

<b>AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT</b>				1. CONTRACT ID CODE		PAGE OF PAGES 1   2	
2. AMENDMENT/MODIFICATION NO. 0007		3. EFFECTIVE DATE 01-Feb-2002		4. REQUISITION/PURCHASE REQ. NO. W68MD9-1205-9694		5. PROJECT NO.(If applicable)	
6. ISSUED BY USA ENGINEER DISTRICT, SEATTLE ATTN: CENWS-CT P.O. BOX 3755 SEATTLE WA 98124-3755		CODE DACA67		7. ADMINISTERED BY (If other than item 6)  <b>See Item 6</b>		CODE	
8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)				X		9A. AMENDMENT OF SOLICITATION NO. DACA67-02-B-0001	
				X		9B. DATED (SEE ITEM 11) 10-Dec-2001	
						10A. MOD. OF CONTRACT/ORDER NO.	
						10B. DATED (SEE ITEM 13)	
CODE		FACILITY CODE					
<b>11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS</b>							
<input checked="" type="checkbox"/> The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer <input type="checkbox"/> is extended, <input checked="" type="checkbox"/> is not extended.  Offer must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.							
12. ACCOUNTING AND APPROPRIATION DATA (If required)							
13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.							
A.THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.							
B.THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(B).							
C.THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:							
D.OTHER (Specify type of modification and authority)							
E. IMPORTANT: Contractor <input type="checkbox"/> is not, <input type="checkbox"/> is required to sign this document and return _____ copies to the issuing office.							
14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.) Solicitation: # DACA67-02-B-0001  Title: Ammunition Supply Point Expansion  AMENDMENT #7  SEE CONTINUATION SHEET							
<small>Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.</small>							
15A. NAME AND TITLE OF SIGNER (Type or print)				16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)			
15B. CONTRACTOR/OFFEROR		15C. DATE SIGNED		16B. UNITED STATES OF AMERICA		16C. DATE SIGNED	
_____ (Signature of person authorized to sign)				BY _____ (Signature of Contracting Officer)		01-Feb-2002	

## SECTION SF 30 BLOCK 14 CONTINUATION PAGE

A. This Amendment No. 7 is issued to provide for revisions to the solicitation as follows:

1. Replaced vision to the Table of Contents.
2. Replaced Specification Sections 02540, 03300, 07416, and 15566.
3. Replaced Sections 00800 (Special Clauses) and 06740

**Revised specification sections supercede and replace corresponding specification sections. New specification sections are added in sequence. Revised drawings replace corresponding drawings. Specification changes are shown lined out for deletions and underlined for additions with a vertical line in the margin.**

- B. The attached revised sections are to be replaced in their entirety. Specification changes are generally identified, for convenience, either by strikeout for deletions, and double underlining of text for additions or a single dark line in the right hand margin. All portions of the revised or new pages shall apply whether or not changes have been indicated.
- C. NOTICE TO BIDDERS: Bidders must acknowledge receipt of this Amendment by Number and Date on the Standard Form 1442 BACK in block 19, or by telegram. Please mark the outside of the envelope in which your bid is enclosed to show amendments received.
- D. The Time/Date of the Bid Opening for this Solicitation is not affected by this Amendment The Time/Date of the Bid Opening remains at **2:00 p.m. on 07 February 2002 .**

Enclosures:

Replaced Table of Contents  
Replaced Specification Sections 02540, 03300, 07416, and 15566.  
Replaced Sections 00800 (Special Clauses) and 06740

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SC-23	RECOVERED MATERIALS

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## SECTION 00800

### SPECIAL CLAUSES

#### SC-1. COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984) (FAR 52.211-10).

The Contractor shall be required to (a) commence work under this Contract within 10 calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 450 calendar days after date of receipt by Contractor of notice to proceed. The time stated for completion shall include final cleanup of the premises.

##### SC-1.1 OPTION FOR INCREASED QUANTITY

a. The Government may increase the quantity of work awarded by exercising Optional Bid Item 0005 at any time, or not at all, but no later than 180 calendar days after receipt by Contractor of notice to proceed. Notice to proceed on work Item added by exercise of the option will be given upon execution of consent of surety.

b. The parties hereto further agree that any option herein shall be considered to have been exercised at the time the Government deposits written notification to the Contractor in the mails.

c. The time allowed for completion of any optional items awarded under this contract will be the same as that for the base items, and will be measured from the date of receipt of the notice to proceed for the base items.

d. Exception to Completion Period: In case the Contracting Officer determines that completion of seeding, sodding, and planting, and establishment of same is not feasible within the completion period stated above, the Contractor shall accomplish such work in the first planting period following the contract completion period and shall complete such work as specified, unless other planting periods are directed or approved by the Contracting Officer.

#### SC-2. LIQUIDATED DAMAGES - CONSTRUCTION (APR 1984) (FAR 52.211-12)

(a) If the Contractor fails to complete the work within the time specified in the Contract, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of \$968.00 for each day of delay.

(b) If the Government terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final completion of the work together with any increased costs occasioned the Government in completing the work.

(c) If the Government does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted.

SC-3 AND SC-4 DELETED.

SC-5. INSURANCE - WORK ON A GOVERNMENT INSTALLATION (SEP 1989) (FAR 52.228-5)

(a) The Contractor shall, at its own expense, provide and maintain during the entire performance period of this Contract at least the kinds and minimum amounts of insurance required in the Insurance Liability Schedule or elsewhere in the Contract.

(b) Before commencing work under this Contract, the Contractor shall certify to the Contracting Officer in writing that the required insurance has been obtained. The policies evidencing required insurance shall contain an endorsement to the effect that any cancellation or any material change adversely affecting the Government's interest shall not be effective:

(1) for such period as the laws of the State in which this Contract is to be performed prescribe; or

(2) until 30 days after the insurer or the Contractor gives written notice to the Contracting Officer, whichever period is longer.

(c) The Contractor shall insert the substance of this clause, including this paragraph (c), in subcontracts under this Contract that require work on a Government installation and shall require subcontractors to provide and maintain the insurance required in the Schedule or elsewhere in the Contract. The Contractor shall maintain a copy of all subcontractors' proofs of required insurance, and shall make copies available to the Contracting Officer upon request.

(d) Insurance Liability Schedule (FAR 28.307-2)

(1) Workers' compensation and employer's liability. Contractors are required to comply with applicable Federal and State workers' compensation and occupational disease statutes. If occupational diseases are not compensable under those statutes, they shall be covered under the employer's liability section of the insurance policy, except when Contract operations are so commingled with a Contractor's commercial operation that it would not be practical to require this coverage. Employer's liability coverage of at least \$100,000 shall be required, except in states with exclusive or monopolistic funds that do not permit workers' compensation to be written by private carriers.

(2) General Liability.

(a) The Contracting Officer shall require bodily injury liability insurance coverage written on the comprehensive form of policy of at least \$500,000 per occurrence.

(b) Property damage liability insurance shall be required only in special circumstances as determined by the agency.

(3) Automobile liability. The Contracting Officer shall require automobile liability insurance written on the comprehensive form of policy. The policy shall provide for bodily injury and property damage liability covering the operation of all automobiles used in connection with performing the Contract. Policies covering automobiles operated in the United States shall provide coverage of at least \$200,000 per person and \$500,000 per occurrence for bodily injury and \$20,000 per occurrence for property damage. The amount of liability coverage on other policies shall be commensurate with any legal requirements of the locality and sufficient to meet normal and customary claims.

(4) Aircraft public and passenger liability. When aircraft are used in connection with performing the Contract, the Contracting Officer shall require aircraft public and passenger liability insurance. Coverage shall be at least \$200,000 per person and \$500,000 per occurrence for bodily injury, other than passenger liability, and \$200,000 per occurrence for property damage. Coverage for passenger liability bodily injury shall be at least \$200,000 multiplied by the number of seats or passengers, whichever is greater.

(5) Environmental Liability If this contract includes the transport, treatment, storage, or disposal of hazardous material waste the following coverage is required.

The Contractor shall ensure the transporter and disposal facility have liability insurance in effect for claims arising out of the death or bodily injury and property damage from hazardous material/waste transport, treatment, storage and disposal, including vehicle liability and legal defense costs in the amount of \$1,000,000.00 as evidenced by a certificate of insurance for General, Automobile, and Environmental Liability Coverage. Proof of this insurance shall be provided to the Contracting Officer.

SC-6. DELETED.

SC-7. PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984) (FAR 52.236-1): The Contractor shall perform on the site, and with its own organization, work equivalent to at least fifteen (15%) percent of the total amount of work to be performed under the Contract. The percentage may be reduced by a supplemental agreement to this Contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

SC-8. PHYSICAL DATA (APR 1984) (FAR 52.236-4): Data and information furnished or referred to below is for the Contractor's information. The Government will not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(a) Physical Conditions: The indications of physical conditions on the drawings and in the specifications are the result of site investigations by test holes shown on the drawings.

(b) Weather Conditions: Each bidder shall be satisfied before submitting his bid as to the hazards likely to arise from weather conditions. Complete weather records and reports may be obtained from any National Weather Service Office.

(c) Transportation Facilities: Each bidder, before submitting his bid, shall make an investigation of the conditions of existing public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress at the jobsite. The unavailability of transportation facilities or limitations thereon shall not become a basis for claims for damages or extension of time for completion of the work.

SC-9. DELETED.

SC-10. LAYOUT OF WORK (APR 1984) (FAR 52.236-17): The Contractor shall lay out its work from Government-established base lines and bench marks indicated on the drawings, and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at its own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer.

The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through its negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due, or to become due, to the Contractor.

SC-11 THROUGH SC-13. DELETED.

SC-14. EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)-  
(EFARS 52.231-5000)

(a) This clause does not apply to terminations. See 52.249-5000, Basis for Settlement of Proposals and FAR Part 49.

(b) Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a contractor or subcontractor at any tier shall be based on actual cost data for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and operating costs from the contractor's accounting records. When both ownership and operating costs cannot be determined for any piece of equipment or groups of similar serial or series equipment from the contractor's accounting records, costs for that equipment shall be based upon the applicable provisions of EP 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule, Region VIII. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the contracting officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the schedule in effect at the time of negotiations shall apply. For retroactive pricing, the schedule in effect at the time the work was performed shall apply.

(c) Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements, will be determined using the schedule, except that actual rates will be used for equipment leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees.

(d) When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the contracting officer shall request the contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate. The data shall be submitted on Standard Form 1411, Contract Pricing Proposal Cover Sheet.

(e) Copies of EP1110-1-8 "Construction Equipment Ownership and Operating Expense Schedule" Volume 4 (Montana) and Volume 8 (Washington, Oregon and Idaho) are available from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, phone (202) 512-1800 and fax (202) 512-2250, OR from the Government Bookstore in the Jackson Federal Building, Seattle, WA, phone (206) 553-4279. The cost is \$33.00 for each volume. Use the following stock numbers when ordering schedules:

S/N 008-022-00317-7                      Volume 4

S/N 008-022-00321-5                      Volume 8



SC-15. PAYMENT FOR MATERIALS DELIVERED OFF-SITE (MAR 1995)-(EFARS 52.232-5000)

(a) Pursuant to FAR clause 52.232-5, Payments Under Fixed Priced Construction Contracts, materials delivered to the contractor at locations other than the site of the work may be taken into consideration in making payments if included in payment estimates and if all the conditions of the General Provisions are fulfilled. Payment for items delivered to locations other than the work site will be limited to: (1) materials required by the technical provisions; or (3) materials that have been fabricated to the point where they are identifiable to an item of work required under this contract.

(b) Such payment will be made only after receipt of paid or receipted invoices or invoices with canceled check showing title to the items in the prime contractor and including the value of material and labor incorporated into the item. In addition to petroleum products, payment for materials delivered off-site is limited to the following items: Any other construction material stored offsite may be considered in determining the amount of a progress payment.

SC-16 AND SC-17. DELETED.

SC-18. CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (OCT 1996) (52.0236-4001 EBS)

(a) The Government--

(1) Will provide the Contractor, without charge, one set of contract drawings and one set of specifications in electronic format on a compact disk. The Government will not give the Contractor any hard copy paper drawings or specifications for any contract resulting from this solicitation.

(b) The Contractor shall--

(1) check all drawings furnished immediately upon receipt;

(2) Compare all drawings and verify the figures before laying out the work;

(3) Promptly notify the Contracting Officer of any discrepancies; and

(4) Be responsible for any errors which might have been avoided by complying with this paragraph (b).

(c) Large scale drawings shall, in general, govern small scale drawings. Figures marked on drawings shall, in general, be followed in preference to scale measurements.

(d) Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the work, but shall be performed as if fully and correctly set forth and described in the drawings and specifications.

(e) The work shall conform to the specifications and the contract drawings identified in the index of drawings attached at the end of the Special Clauses.

SC-19 Through SC-21 DELETED.

SC-22. EPA ENERGY STAR: The Government requires that certain equipment be Energy Star compliant. Initially, the sole Energy Star requirement shall be the self certification by the bidder that the specified equipment is Energy Star compliant. Within 3 months of the availability of an EPA sanctioned test for Energy Star compliance, the Contractor shall submit all equipment upgrades and additions for testing and provide proof of compliance to the Government upon completion of testing. Testing shall be at the Contractor's expense.

SC-23. RECOVERED MATERIALS: The Corps of Engineers encourages all bidders to utilize recovered materials to the maximum extent practicable. The attached APPENDIX R contains procurement guidelines for products containing recovered materials.

## APPENDIX R

### PART 247 - COMPREHENSIVE PROCUREMENT GUIDELINE FOR PRODUCTS CONTAINING RECOVERED MATERIALS

40 CFR Ch. 1 (9-1-99 Edition)

Subpart B-Item Designations

§ 247.10 Paper and paper products.

Paper and paper products, excluding building and construction paper grades.

§ 247.11 Vehicular products.

(a) Lubricating oils containing re-refined oil, including engine lubricating oils, hydraulic fluids, and gear oils, excluding marine and aviation oils.

(b) Tires, excluding airplane tire

(e) Reclaimed engine coolants, excluding coolants used in non-vehicular applications.

247.12 Construction products.

Building insulation product including the following items:

(1) Loose-fill insulation, including but not limited to cellulose fiber, mineral fibers (fiberglass and rock vermiculite, and perlite;

(2) Blanket and batt insulation, including but not limited to mineral fibers (fiberglass and rock wool).

Board (sheathing, roof decking wall panel) insulation, including but not limited to structural fiberboard and laminated paperboard products perlite composite board, polyurethane, polyisocyanurate, polystyrene, phenolics, and composites; and

Spray-in-place insulation, including but not limited to foam-in-place polyurethane and polyisocyanurate and spray-on cellulose.

(b) Structural fiberboard and laminated paperboard products for applications other than building insulation, including building board, sheathing shingle backer, sound deadening board, roof insulating board, insulating wallboard, acoustical and non-acoustical ceiling tile, acoustical and non-acoustical lay-in panels, floor underlayments, and roof overlay (cover board).

(c) Cement and concrete, including concrete products such as pipe and block, containing coal fly as ground granulated blast furnace (GGBF) slag.

(d) Carpet made of polyester fiber use in low- and medium-wear applications.

(e) Floor tiles and patio block containing recovered rubber or plastic.

(f) Shower and restroom dividers/partitions containing recovered plastic or steel.

(g) (1) Consolidated latex paint used for covering graffiti; and

(2) Reprocessed latex paint used for interior and exterior architectural applications such as wallboard, ceilings, and trim; gutter boards; and concrete, stucco, masonry, wood and metal surfaces.

#### §247.13 Transportation products.

(a) Traffic barricades and traffic cones used in controlling or restricting vehicular traffic.

(b) Parking stops made from concrete or containing recovered plastic or rubber.

(c) Channelizers containing recovered plastic or rubber.

(d) Delineators containing recovered plastic, rubber, or steel.

(e) Flexible delineators containing recovered plastic.

#### § 247.14 Park and recreation products

(a) Playground surfaces and running tracks containing recovered rubber or plastic.

(b) Plastic fencing containing recovered plastic for use in controlling snow or sand drifting and as a warning/safety barrier in construction or other applications.

#### 247.15 Landscaping products.

(a) Hydraulic mulch products containing recovered paper or recovered wood used for hydroseeding and as an over-spray for straw mulch in landscaping, erosion control, and soil reclamation.

(b) Compost made from yard trimmings, leaves, and/or grass clippings for use in landscaping, seeding of grass or other plants on roadsides and embankments, as a nutritious mulch under trees and shrubs, and in erosion control and soil reclamation.

(c) Garden and soaker hoses containing recovered plastic or rubber.

(d) Lawn and garden edging containing recovered plastic or rubber.

#### § 247.16 Non-paper office product.

(a) Office recycling containers and office waste receptacles.

(b) Plastic desktop accessories.

(c) Toner cartridges.

Binders.

Plastic trash bags.

Printer ribbons.

Plastic envelopes.

#### § 247.17 Miscellaneous products.

Pallets containing recovered wood, plastic, or paperboard.

AMMUNITION SUPPLY POINT EXPANSION

FT. LEWIS, WASHINGTON

DACA67-02-B-0001

Drawing File No. 24s/421-90-01

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105	E-18	Grounding		01OCT01
106	E-19	Pump House		01OCT01
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107	E-20	Telecom System and Details	A	02JAN03
108	E-21	Enlarged Comm Room		01OCT01



SHEET NUMBER	PLATE NUMBER	TITLE	REV. NO.	DATE
		Reference Files:		01OCT01
109	E-22	Magazine, Concrete, Electrical Plan & Section		01OCT01
110	E-23	Magazine, Concrete, Electrical Details		01OCT01

### REVISIONS TO DRAWINGS BY NOTATION

Drawing Sheet 12, Pl. C-2:

- (a) At the end of Note 8, add "Gravel shall be at least 100 mm deep."
- (b) Add "Note 13. Concrete pads shall be installed in front of each igloo. Concrete pads shall be 3.6 m x 3.6 m. Concrete pad thickness, base course and subgrade shall be as shown in the Concrete Apron Loading Pad Section on Plate C-31."
- (c) Add "Note 14. The retaining wall shown at the ammunition storage igloos shall be continuous as shown in "Partial Elevation-Portal Wall" and "Partial Plan-Portal Wall" on Sheet 70. The retaining wall shall be continuous for each set of igloos."

Drawing Sheet 13, Pl. C-3:

- (a) At the end of Note 7, add "Gravel shall be at least 100 mm deep."
- (b) Revise Note 9 to read, "Pumphouse. Contractor shall provide an insulated pre-engineered building with .....shown in mechanical and electrical drawings. See Plates M-5, M-6 and A-12 for details."
- (c) Add "Note 14. Provide all Guard Shacks. Guard Shacks shall be insulated preengineered metal buildings with one wire-glass window on the side of the building and another wire-glass window in the door. All components shall be designed (including seismic), fabricated and installed with all appurtances for a complete self-contained structure. Buildings shall be painted on the exterior. Color shall be selected by the Contracting Officer. Provide seismic restraints. Install Guard Shacks on 125mm thick reinforced concrete pads. Pads shall be level. Pads shall be 35 mm above adjacent grade. Guard shacks shall be 3.048 m x 3.048 m x 2.74 m clear interior height."
- (d) Add "Note 15. Concrete pads shall installed in front of each igloo. Concrete pads shall be 3.6 m x 3.6 m. Concrete pad thickness, base course and subgrade shall be as shown in the Concrete Apron Loading Pad section on Plate C-31."

Drawing Sheet 44, Pl. A-2:

- (a) Change thickness of CONCRETE APRON on north and west side of building from 152 mm to 200 mm. Change westerly dimension of CONCRETE APRON from 4320 to 7620.
- (b) Dimensions of Recessed Mats located at Columns F 1 and F 5 shall be approximately 1000 mm wide by 1000 mm long.

(c) Add "NOTE. Floor area between Column A and Column E shall receive conductive sparkproof industrial resin-based flooring as specified in specification Section 09670."  
Drawing Sheet 47, Pl. A-5: For door between columns 4 and 5, change width to 3660.

Drawing Sheet 50, Pl. A-8:

(a) DETAIL B (TYPICAL BOLLARD DETAIL): Change 200 mm to 152.4 mm.

(b) ROOM FINISH SCHEDULE:

(1) Room No. 1 (Shop): Under FLOOR FIN, change "STL TRL" to "See Remarks". Under REMARKS, change to "Open to Structures (No Ceiling). Conductive Sparkproof Flooring (See Spec Sec. 09670)."

(2) Room Nos. 7 and 8: Under REMARKS, after "Open to Structures" add "(No Ceiling)".

Drawing Sheet 51, Pl. A-9, Detail 4:

(a) Delete bollard located inside the building.

(b) Add Note: "No bollards will be located inside the building".

Drawing Sheet 53, Pl. A-11:

(a) DOOR SCHEDULE: For Doors 1D, 1E, 1F, 1G, and 1H, change Door height from 4.267m to 3.66m. Change Mark 1J from 3.6 m X 4.26 m to 3.048 m x 3.048 m.

(b) DOOR TYPE "F": Change door height from 4.267 m to 3.66 m.

Drawing Sheet 54, Pl. A-12: Add "Build Note 1. The Pumphouse shown on this Plate shall be an insulated, pre-engineered building. All components shall be designed (including seismic), fabricated and installed with all appurtenances for a complete self-contained structure (including footings and floor slab). Provide waterproof, locking hatch that will allow access to pump well components for removal (see Roof Plan, this sheet). Building shall be painted on the exterior. Color shall be selected by the Contracting Officer. All work shall be coordinated and installed under a single source."

Drawing Sheet 69, Pl. S-15, SECTION A: Change "Impervious Fill" to "Select Cohesive Structural Fill (See specification Section 02221)".

Drawing Sheet 78, Pl. M-4: Add "Note 5. Ductwork Layout in Room 7 is suggested. Deviations in routing of supply, return, outside air and relief ducts are acceptable. Adjustments in the location of the outside air and relief louvers shown on Plate A-5 is permissible."

Drawing Sheet 86, Pl. M-12, Supply Fan Operating note: Remove "& EF-2". Add "See Spec Section 15951 for economizer sequence."

### REFERENCE DRAWINGS

Reference drawings provided show conditions at time of construction. These drawings are furnished for information only and the Government does not warrant that conditions will be exactly as shown. Minor deviations can be anticipated and shall not be the basis for a claim for extra compensation.

FILE NUMBER	SHEET NUMBER	TITLE	REVISION NUMBER	DATE
24S/422-90-04		MAGAZINE, CONCRETE OVAL-ARCH EARTH-COVERED		
	0	Cover		79APR11
	1	Plan and Sections		79APR11
	2	Portal Wall Plan, Elevations and Details		79APR11
	3	Portal and Rear Wall Plan, Elevation and Sections		79APR11
	4	Miscellaneous Details		79APR11
	5	10'-0" Blast Door		79APR11
	6	8'-0" Blast Door		79APR11
	7	Miscellaneous Blast Door Details		79APR11
	8	Electrical Plan and Sections		79APR11
	9	Electrical Details		79APR11

### STANDARD DETAILS BOUND IN THE SPECIFICATIONS

DRAWING NUMBER	SHEET NUMBER	TITLE	DATE
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### SECTION 01501 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

1	Hard Hat Sign	10SEP90
1 & 2	U.S. Army Project Sign	84JUN20

END OF SECTION

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Section  
No.

Section Title

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| 13120 | Standard Metal Building Systems                         |
| 13122 | Earth-Covered Magazine                                  |

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16740	Telephone System
16768	Fiber Optic Data Transmission System

## SECTION 02540

### DRAINFIELDS

#### PART 1 GENERAL

##### 1.1 SUMMARY (Not Applicable)

##### 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

##### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 127	(1988) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 136	(1996) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987) Sampling Aggregates
ASTM D 2751	(1996; Rev. A) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 3034	(1997) Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM D 4632	(1991) Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1987) Determining Apparent Opening Size of a Geotextile
ASTM E 11	(1987) Wire-Cloth Sieves for Testing Purposes

##### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330; SUBMITTAL PROCEDURES:

Samples GA.

Samples of filter fabric, pipe, and pipe fittings shall be submitted and approved before starting the work.

Test Reports GA.

Source of drainfield aggregate shall be selected well in advance of the time that materials will be required in the work. Test results from samples shall be submitted for approval not less than 30 days before material is required for the work.

Certificates of Compliance FIO.

Certifications from the manufacturers attesting that materials meet specification requirements shall be submitted. Certificates are required for drain pipe, drain tile and filter fabric. Results of laboratory tests of drainfield aggregate gradation shall be submitted for control purposes.

## 1.4 DELIVER, STORAGE, AND HANDLING

### 1.4.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with minimum handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. During shipment and storage, filter fabric shall be wrapped in burlap or similar heavy duty protective covering. The storage area shall be such that the fabric is protected from mud, soil, dust, and debris. Filter fabric materials that are not to be installed immediately shall not be stored in direct sunlight. Plastic pipe shall be installed within 6 months from the date of manufacture unless otherwise approved.

### 1.4.2 Handling

Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried and not dragged to the trench.

## 1.5 SAMPLING AND TESTING

### 1.5.1 General Requirements

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory, or by the Contractor subject to approval. Tests shall be performed in sufficient number to insure that materials meet specified requirements. Copies of test results shall be furnished to the Contracting Officer. Samples for material gradation shall be taken in conformance with ASTM D 75. Samples required during production shall be the basis for approval of specified lots from the standpoint of all requirements except gradation. When deemed necessary, the sampling of materials will be observed by the Contracting Officer; however, samples to be used as the basis for final approval in determining gradation shall always be obtained under observation of the Contracting Officer.

### 1.5.2 Tests

Sieve analyses shall be made in conformance with ASTM C 127 and C 136. Sieves shall conform to ASTM E 11.

### 1.5.3 Approval of Material

The source of the material to be used shall be selected well in advance of the time materials will be required in the work. Tentative approval of the source will be based on an inspection by the Contracting Officer. Tentative approval of the material will be based on results of samples from test pits, borings, or other excavations, or from samples of current production in the case of an existing producer. Final approval of material from the standpoint of gradation and density shall be based on tests made on the completed in-place material layer. The completed layer is defined as a layer that is ready for the next layer.

## 1.6 STOCKPILING MATERIAL

Prior to stockpiling of material, the storage site shall be cleared, drained, and leveled. material shall be stockpiled in the manner and at the locations designated by the Contracting Officer. Different borrow materials shall be stockpiled separately so as to prevent segregation.

## PART 2 PRODUCTS

### 2.1 PIPE FOR DRAINFIELD

Pipe for drainfield shall be of the types and sizes indicated.

#### 2.1.1 Plastic Pipe

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

##### 2.1.1.1 Acrylonitrile-Butadiene-Styrene (ABS) Piping

Acrylonitrile-butadiene-styrene (ABS) piping and fittings shall conform to ASTM D 2751, with maximum SDR of 35.

##### 2.1.1.2 Polyvinyl Chloride (PVC) Pipe and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034, Type PS 46.

##### 2.1.1.3 Pipe Perforations

Orifice size and spacing shall be as shown. Circular holes shall be cleanly cut and arranged in rows parallel to the longitudinal axis of the pipe. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

### 2.2 FILTER FABRIC

Filter fabric shall be a pervious sheet of polyester, nylon, or polypropylene filaments woven or otherwise formed into a uniform pattern with distinct and measurable openings. The filter fabric shall provide an equivalent opening size (EOS) no finer than the US Standard Sieve No. 100 and no coarser than the US Standard Sieve No. 70 in accordance with ASTM D 4751. EOS is defined as the number of the US Standard sieve having openings closest in size to the filter fabric openings. The fabric shall contain stabilizers and/or inhibitors added to the base material to make it resistant to deterioration due to ultraviolet and heat exposure. The fabric shall have a minimum physical strength of 36.78 newtons per mm in any direction when tested in accordance with ASTM D 4632 using the grab test method with 1 square inch jaws and a constant rate of travel of 300 mm per minute. Elongation at failure shall be 30 percent minimum in any principal direction. The fabric shall be constructed so that the filaments will retain their relative position with respect to each other. The edges of the fabric shall be salvaged or otherwise finished to prevent the outer material from pulling away from the fabric. The fabric

shall be woven into a width such that it may be installed with a maximum of two overlapping or three field sewn longitudinal seams.

## 2.3 DRAINFIELD AGGREGATE AND SATISFACTORY BACKFILL MATERIAL

### 2.3.1 Drainfield Aggregate

Drainfield aggregate shall be washed gravel, crushed stone, crushed stone screenings, or slag composed of hard, tough, durable particles free from adherent coatings. Material shall not contain corrosive agents, organic matter, or soft, friable, thin, or elongated particles and shall be evenly graded between the limits specified in TABLE I. Gradation curves will exhibit no abrupt changes in slope denoting skip or gap grading. Materials shall be clean and free from soil and foreign materials. Materials found to be dirty or otherwise contaminated shall be removed and replaced with material meeting the specific requirements, at no additional cost to the Government.

TABLE I. FILTER GRADATION

Passing 65 mm Sieve (square opening)	100 Percent by Weight
Passing 20 mm Sieve	0-2 Percent by Weight

### 2.3.2 Satisfactory Backfill

Satisfactory backfill material shall consist of excavated material conforming to the requirements for satisfactory material specified in SECTION: 02300 GRADING (EARTHWORK).

## PART 3 EXECUTION

### 3.1 EQUIPMENT

All plant, equipment, tools, and machines used in the performance of the work shall be approved prior to commencement of work and shall be maintained in satisfactory working condition at all times.

#### 3.1.1 Hauling Equipment

Hauling equipment shall consist of pneumatic-tired vehicles having dump bodies suitable for dumping materials next to the drainfields being constructed. No hauling equipment shall be allowed within the drainfield area or within 15 M downslope of the drainfield.

#### 3.1.2 Miscellaneous Equipment

Tractors and other equipment shall be of approved types, suitable for constructing drainfields.

### 3.2 GRADE CONTROL

During construction, the lines and grades indicated for the construction of the drainfields shall be maintained by means of line and grade stakes placed by the Contractor.

### 3.3 EXCAVATION FOR DRAINFIELD AND TRANSPORT PIPE

Trenching and excavation, including the removal of rock and unstable material, shall be in accordance with SECTION ~~02224~~ **02316: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS**. The subgrade for drainfield aggregate and piping system shall be constructed with furrows parallel to the pipe laterals as shown.

### 3.4 PLACING OF DRAINFIELD AGGREGATE

Drainfield aggregate shall be placed on the prepared subgrade in layers of uniform thickness. The material shall be placed in layers of equal thickness. No layer shall exceed 150 mm or be less than 80 mm when compacted. The layers shall be so placed that when deposited, they will be true to the grade or levels required with the least possible surface disturbance. Drainfield aggregate shall be placed and leveled to the elevation required for placing the distribution laterals.

### 3.5 INSTALLATION OF PIPE FOR SUBDRAINS

#### 3.5.1 Pipelaying

Each pipe shall be carefully inspected before it is laid. Any defective or damaged pipe shall be rejected. No pipe shall be laid when conditions or weather is unsuitable for such work. Water shall be removed from trenches by sump pumping or other approved methods. The pipe shall be laid to the grades and alignment as indicated. The pipe shall be bedded to the established gradeline. Perforations shall be centered on the bottom of the pipe. Pipes of either the bell-and-spigot type or the tongue-and-groove type shall be laid with the bell or groove ends upstream. Thrust blocking shall be placed at appropriate locations according to SECTION ~~02730~~ **02531: SANITARY SEWERS AND SEPTIC SYSTEM**. All pipes in place shall be approved and tested before backfilling.

#### 3.5.2 Jointings

a. Acrylonitrile-Butadiene-Styrene (ABS): Solvent cement or elastomeric joints for ABS pipe shall be in accordance with ASTM D 2751. Dimensions and tolerances shall be in accordance with TABLE II of ASTM D 2751.

b. Polyvinyl Chloride (PVC) Pipe: Joints shall be in accordance with the requirements of ASTM D 3034.

#### 3.5.3 Testing

After the distribution laterals have been placed and leveled on the bed of aggregate the manifold pipe attached to the transport pipe and distribution laterals, the system shall be tested in accordance with SECTION: ~~02531 SANITARY SEWERS AND SEPTIC SYSTEM~~ **FORGE MAINS AND INVERTED SIPHONS; SEWER**.

### 3.6 INSTALLATION OF DRAINFIELD AGGREGATE, FILTER FABRIC, AND BACKFILLING

After pipe for subdrains has been laid, inspected, tested, and approved, drainfield aggregate shall be placed around and over the pipe to the depth indicated. The drainfield aggregate shall be thoroughly compacted by mechanical tampers or rammers to obtain the required density. Compaction of drainfield aggregate and the placement and compaction of overlying backfill material shall be in accordance with the applicable provisions specified in SECTION ~~02224~~ 02316: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

Filter fabric shall be placed on the drainfield aggregate surface in accordance with the manufacturer's recommended procedures. The surface shall be free of cavities, depressions, or projecting rocks. The fabric shall be laid flat but not stretched and shall be secured with anchor pins. Overlaps shall be at least 457 mm but not less than the manufacturer's recommended overlap. Anchor pins shall be used along the overlaps. Spacing and type of anchor pins shall be as recommended by the fabric manufacturer. The filter fabric shall be protected from exposure to ultraviolet light, and during installation fabric shall be covered the same day that it is laid. Backfill material shall be end dumped on firm ground at the edge of the fabric and spread over the filter fabric material in a manner which prevents damage to the fabric. The pipe distribution system shall be protected from damage due to excessive loading or other Contractor operations. No wheeled equipment shall be drive over the top of the bed where pipes are located or the bed might be damaged.

END OF SECTION



## SECTION 03300

### CONCRETE FOR BUILDING CONSTRUCTION

#### PART 1 GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

#### AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182 (1991I) Burlap Cloth Made From Jute or Kenaf

#### ACI INTERNATIONAL (ACI)

ACI 117/A117R (1990; Errata) Standard Tolerances for Concrete Construction and Materials

ACI 211.1 (1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

ACI 211.2 (1991) Standard Practice for Selecting Proportions for Structural Lightweight Concrete

ACI 213R (1987) Guide for Structural Lightweight Aggregate Concrete

ACI 214.3R (1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete

ACI 301 (1996) Specifications for Structural Concrete for Buildings

ACI 303R (1991) Guide to Cast-In-Place Architectural Concrete Practice

ACI 305R (1991) Hot Weather Concreting

ACI 318/318R (1995) Building Code Requirements for Reinforced Concrete and Commentaries

#### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31 (1991) Making and Curing Concrete Test Specimens in the Field

ASTM C 33 (1993) Concrete Aggregates

ASTM C 39 (1994) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 42	(1994) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 94	(1995) Ready-Mixed Concrete
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 171	(1995) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 173	(1994a) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192	(1990a) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 309	(1995) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 330	(1989) Lightweight Aggregates for Structural Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 496	(1990) Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 567	(1991) Unit Weight of Structural Lightweight Concrete
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation

ASTM C 595	(1994a) Blended Hydraulic Cements
ASTM C 618	(1995) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 685	(1995) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 937	(1980, R 1991) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C 940	(1989) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C 989	(1994a) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	(1992) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1991) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064	(1986, R 1993) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1995b) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1991a) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1116	(1991) Fiber-Reinforced Concrete and Shotcrete
ASTM C 1240	(1995) Silica Fume for Use in Hydraulic Cement Concrete and Mortar
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 96	(1995) Water Vapor Transmission of Materials

ASTM E 1155 (1987) Determining Floor Flatness and Levelness Using the F-Number System

CORPS OF ENGINEERS (COE)

COE CRD-C 94 (1995) Surface Retarders

COE CRD-C 104 (1980) Method of Calculation of the Fineness Modulus of Aggregate

COE CRD-C 400 (1963) Requirements for Water for Use in Mixing or Curing Concrete

COE CRD-C 521 (1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

COE CRD-C 540 (1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type

COE CRD-C 572 (1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44 (1995) NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA TMMB-01 (1992) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards of the Truck Mixer Manufacturers Bureau

NRMCA CPMB 100 (1990) Concrete Plant Standards

NRMCA QC 3 (1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTALS:

#### Statements

Mixture Proportions;.

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture design studies without additional tests to show that the quality of the concrete is satisfactory.

#### Reports

Testing and Inspection for Contractor Quality Control; GA.

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

#### Certificates

Qualifications; FIO.

Written documentation for Contractor Quality Control personnel.

### 1.3 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades or shall have written evidence of having completed similar qualification programs:

- Concrete Field Testing Technician, Grade I
- Concrete Laboratory Testing Technician, Grade I or II
- Concrete Construction Inspector, Level II

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation.

### 1.4 GENERAL REQUIREMENTS

#### 1.4.1 Tolerances

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with ACI 117/A117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing; when forms or shoring are used, the measurements shall be made prior to removal.

##### 1.4.1.1 Floors

For the purpose of this Section the following terminology correlation between ACI 117/A117R and this Section shall apply:

<u>Floor Profile Quality</u> <u>Classification From ACI 117/A117R</u>	<u>This Section</u>
Conventional Bullfloated	Same
Conventional Straightedged	Same
Flat	Float Finish or Trowel Finish

Levelness tolerance shall not apply where design requires floors to be sloped to drains or sloped for other reasons.

##### 1.4.1.2 Floors by the Straightedge System

The flatness of the floors shall be carefully controlled and the tolerances shall be measured by the straightedge system as specified in paragraph 4.5.7 of ACI 117/A117R, using a 3 m straightedge, within 72 hours after floor slab installation and before shores and/or forms are removed. The listed tolerances shall be met at any and every location at which the straightedge can be placed.

Straightedged	8 mm
Float Finish	5 mm
Trowel Finish	5 mm

#### 1.4.2 Strength Requirements and w/c Ratio

##### 1.4.2.1 Strength Requirements

Specified compressive strength ( $f'_c$ ) shall be as follows:

<u>COMPRESSIVE STRENGTH</u>	<u>STRUCTURE OR PORTION OF STRUCTURE</u>
27.5 MPa at 28 days 35.0 Mpa at 28 days	All concrete for building construction Test cubicle, storage cubicles, blast walls, and all concrete greater than 400 mm thick
Concrete slabs on-grade shall have a 28-day flexural strength of 4.5 MPa. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II Portland cement. Compressive strength shall be determined in	

accordance with ASTM C 39. Flexural strength shall be determined in accordance with ASTM C 78.

a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (152 by 305 mm cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength  $f'_c$  and no individual test result falls below the specified strength  $f'_c$  by more than 3.5 MPa. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 3.5 MPa or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.

c. Load Tests. If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

d. Evaluation of Concrete Flexural Strength. Flexural strength specimens (beams) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 78. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified flexural strength and no individual test result falls below the specified flexural strength by more than 350 kPa. A "test" is defined as the average of two companion beams. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the slab is considered potentially deficient.

#### 1.4.2.2 Water-Cement Ratio

Maximum water-cement ratio (w/c) for normal weight concrete shall be as follows:

<u>WATER-CEMENT RATIO, BY WEIGHT</u>	<u>STRUCTURE OR PORTION OF STRUCTURE</u>
0.45	All concrete for building construction

This w/c may cause higher strengths than that required above for compressive or flexural strength. The maximum w/c required will be the equivalent w/c as determined by conversion from the weight ratio of water to cement plus pozzolan, by the weight equivalency method as described in ACI 211.1.

#### 1.4.3 Air Entrainment

All normal weight concrete shall be air entrained to contain between 4 and 7 percent total air, except that when the nominal maximum size coarse aggregate is 19 mm or smaller it shall be between 4.5 and 7.5 percent. Specified air content shall be attained at point of placement into the forms. Air content for normal weight concrete shall be determined in accordance with ASTM C 231.

#### 1.4.4 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143.

<u>Structural Element</u>	<u>Slump, Minimum</u>	<u>Slump, Maximum</u>
Blast and Fragment Resistant Walls	100 mm	150 mm
Walls, columns and beams	50 mm	100 mm
Foundation walls, substructure walls, footings, slabs	25 mm	75 mm
Any structural concrete approved for placement by pumping:		
At pump	50 mm	150 mm
At discharge of line	25 mm	100 mm

When use of a plasticizing admixture conforming to ASTM C 1017 or when a Type F or G high range water reducing admixture conforming to ASTM C 494 is permitted to increase the slump of concrete, concrete shall have a slump of 50 to 100 mm before the admixture is added and a maximum slump of 200 mm at the point of delivery after the admixture is added.

#### 1.4.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 32 degrees C. When the ambient temperature during placing is 5 degrees C or less, or is expected to be at any time within 6 hours after placing, the temperature of the concrete as delivered shall be between 12 and 25 degrees C.



#### 1.4.6 Size of Coarse Aggregate

The largest feasible nominal maximum size aggregate (NMSA) specified in paragraph AGGREGATES shall be used in each placement. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum cover for reinforcing bars, three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

#### 1.4.7 Special Properties and Products

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies.

#### 1.4.8 Level and Grade

Variation in alignment, grade, and dimensions of the structure from the established alignment, grade, and dimensions shown on the drawings shall be within the tolerances specified as follows:

##### TOLERANCES FOR STRUCTURES

Departure from established alignment		25 mm
Departure from established grades		25 mm
Variation from the plumb or the specified batter in the lines and surfaces of columns and piers	Exposed, in 3 meters	12.5 mm
	Backfilled, in 3 meters	25 mm
Variation from the level or from the grades indicated on the drawings in decks, beams, and railing offsets	Exposed, in 3 meters	12.5 mm
	Backfilled, in 3 meters	25 mm
Variation in the cross-sectional dimensions of columns, piers, decks, beams, and similar parts	Minus	6.25 mm
	Plus	12.5 mm
Variation in thickness of bridge decks and slabs		12.5 mm
Footings	Minus	12.5 mm

Plus

12.5 mm

## 1.5 MIXTURE PROPORTIONS

Concrete shall be composed of portland cement, other cementitious and pozzolanic materials as specified, aggregates, water and admixtures as specified.

### 1.5.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Except as specified for flexural strength concrete, mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192 and tested in accordance with ASTM C 39. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratios required in the paragraph Maximum Allowable w/c Ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations in ACI 211.1 for the term P, which is used to denote the weight of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by weight of the total cementitious material, and the maximum shall be 35 percent. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

### 1.5.2 Proportioning Studies for Flexural Strength Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall conform to the requirements specified in paragraph Proportioning Studies for Normal Weight Concrete, except that proportions shall be based on flexural strength as determined by test specimens (beams) fabricated in accordance with ASTM C 192 and tested in accordance with ASTM C 78.

Procedures given in ACI 211.1 shall be modified as necessary to accommodate flexural strength.

### 1.5.3 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength ( $f'_{cr}$ ) exceeding the specified compressive strength ( $f'_c$ ) by the amount indicated below. This required average compressive strength,  $f'_{cr}$ , will not be a required acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below  $f'_{cr}$  during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day  $f'_{cr}$ , the mixture shall be adjusted, as approved, to bring the daily average back up to  $f'_{cr}$ . During production, the required  $f'_{cr}$  shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

#### 1.5.3.1 Computations from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths ( $f'_c$ ) within 7 MPa of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Required average compressive strength  $f'_{cr}$  used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'_{cr} = f'_c + 1.34S$$

$$f'_{cr} = f'_c + 2.33S - 500$$

Where  $S$  = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

#### 1.5.3.2 Computations without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength  $f'_{cr}$  shall be determined as follows:

- a. If the specified compressive strength  $f'_c$  is less than 20 Mpa,

$$f'_{cr} = f'_c + 6.9 \text{ MPa}$$

- b. If the specified compressive strength  $f'_c$  is 20 to 35 Mpa,

$$f'_{cr} = f'_c + 8.3 \text{ MPa}$$

- c. If the specified compressive strength  $f'_c$  is over 35 MPa,

$$f'_{cr} = f'_c + 9.7 \text{ MPa}$$

#### 1.5.4 Average Flexural Strength Required for Mixtures

The mixture proportions selected during mixture design studies for flexural strength mixtures and the mixture used during concrete production shall be designed and adjusted during concrete production as approved, except that the overdraft for average flexural strength shall simply be 15 percent greater than the specified flexural strength at all times.

### 1.6 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

### 1.7 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

#### 1.7.1 Materials

The Government may sample and test aggregates, cementitious materials, other materials, and concrete to determine compliance with the specifications as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

#### 1.7.2 Fresh Concrete

Fresh concrete will be sampled by the Contractor as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

#### 1.7.3 Hardened Concrete

Tests on hardened concrete may be performed by the Government when such tests are considered necessary.

#### 1.7.4 Inspection

Concrete operations may be tested and inspected by the Government as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

### PART 2 PRODUCTS

#### 2.1 CEMENTITIOUS MATERIALS

Cementitious Materials shall be portland cement, or portland cement in combination with pozzolan and shall conform to appropriate specifications listed below. Use of cementitious materials in concrete which will have surfaces exposed in the completed structure shall be restricted so there is no change in color, source, or type of cementitious material.

##### 2.1.1 Portland Cement

ASTM C 150, Type I, low alkali with a maximum 15 percent amount of tricalcium aluminate or Type II, low alkali, including false set requirements.

##### 2.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III with tricalcium aluminate limited to 5 percent, low alkali. Type III cement shall be used only in isolated instances and only when approved in writing.

##### 2.1.3 Pozzolan (Fly Ash)

ASTM C 618, Class F with the optional requirements for multiple factor, drying shrinkage, and uniformity from Table 2A of ASTM C 618. Requirement for maximum alkalies from Table 1A of ASTM C 618 shall apply. If pozzolan is used, it shall never be less than 15 percent nor more than 35 percent by weight of the total cementitious material.

#### 2.2 AGGREGATES

Aggregates shall conform to the following.

#### 2.2.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

#### 2.2.2 Coarse Aggregate

Coarse aggregate shall conform to ASTM C 33, Class 5S, size designation 57 or 67.

### 2.3 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

#### 2.3.1 Air-Entraining Admixture

ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

#### 2.3.2 Accelerating Admixture

ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

#### 2.3.3 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

#### 2.3.4 High-Range Water Reducer

ASTM C 494, Type F or G, except that the 6-month and 1-year strength requirements are waived. The admixture shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

#### 2.3.5 Other Chemical Admixtures

Chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017, Type I or II. These admixtures shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

### 2.4 CURING MATERIALS

#### 2.4.1 Impervious-Sheet

Impervious-sheet materials shall conform to ASTM C 171, type optional, except, that polyethylene sheet shall not be used.

#### 2.4.2 Membrane-Forming Compound

Membrane-Forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except that only a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived.

#### 2.4.3 Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

### 2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

### 2.6 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107, Grade A, and shall be a commercial formulation suitable for the proposed application.

### 2.7 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

### 2.8 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

### 2.9 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified in SECTION: ACOUSTICAL CEILINGS. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

### 2.10 PERIMETER INSULATION

Perimeter insulation shall be polystyrene conforming to ASTM C 578, Type II; polyurethane conforming to ASTM C 591, Type II; or cellular glass conforming to ASTM C 552, Type I or IV.

## 2.11 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 0.15 mm or other equivalent material having a vapor permeance rating not exceeding 30 nanograms per Pascal per second per square meter as determined in accordance with ASTM E 96.

## 2.12 JOINT MATERIALS

### 2.12.1 Joint Fillers, Sealers, and Waterstops

Expansion joint fillers shall be preformed materials conforming to ASTM D 1752. Materials for waterstops shall be in accordance with Section 03250 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS. Materials for and sealing of joints shall conform to the requirements of Section 07920 JOINT SEALING.

### 2.12.2 Contraction Joints in Slabs

Contraction joints in slabs shall be sawed.

## PART 3 EXECUTION

### 3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Forms shall be in place, cleaned, coated, and adequately supported, in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

#### 3.1.1 Foundations

##### 3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

##### 3.1.1.2 Preparation of Rock

Rock surfaces upon which concrete is to be placed shall be free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached or unsound fragments.



Joints in rock shall be cleaned to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the concrete is placed, rock surfaces shall be cleaned thoroughly by the use of air-water jets or sandblasting as specified below for Previously Placed Concrete. Rock surfaces shall be kept continuously moist for at least 24 hours immediately prior to placing concrete thereon. All horizontal and approximately horizontal surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar proportioned similar to that in the concrete mixture. Concrete shall be placed before the mortar stiffens.

### 3.1.2 Vapor Barrier

Vapor barrier shall be provided beneath the interior on-grade concrete floor slabs. The greatest widths and lengths practicable shall be used to eliminate joints wherever possible. Joints shall be lapped a minimum of 300 mm. Torn, punctured, or damaged vapor barrier material shall be removed and new vapor barrier shall be provided prior to placing concrete. For minor repairs, patches may be made using laps of at least 300 mm. Lapped joints shall be sealed and edges patched with pressure-sensitive adhesive or tape not less than 50 mm wide and compatible with the membrane. Vapor barrier shall be placed directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, the surface shall be choked with a light layer of sand, as approved, before placing the vapor barrier.

### 3.1.3 Perimeter Insulation

Perimeter insulation shall be installed at locations indicated. Adhesive shall be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

### 3.1.4 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding shall not be performed on embedded metals within 600 mm of the surface of the concrete. Tack welding shall not be performed on or to embedded items.

## 3.2 CONCRETE PRODUCTION

### 3.2.1 Batching, Mixing, and Transporting Concrete

Concrete shall either be furnished from a ready-mixed concrete plant. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB-01. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall conform to the following subparagraphs.

### 3.2.1.1 General

The batching plant shall be located off site close to the project. The batching, mixing and placing system shall have a capacity of at least 100 cubic meters per hour. The batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

### 3.2.1.2 Batching Equipment

The batching controls shall be semiautomatic or automatic, as defined in NRMCA CPMB 100. A semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. The weight of water and admixtures shall be recorded if batched by weight. Separate bins or compartments shall be provided for each size group of aggregate and type of cementitious material, to prevent intermingling at any time. Aggregates shall be weighed either in separate weigh batchers with individual scales or, provided the smallest size is batched first, cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cementitious material. If both portland cement and other cementitious material are used, they may be batched cumulatively, provided that the portland cement is batched first. Water may be measured by weight or volume. Water shall not be weighed or measured cumulatively with another ingredient. Filling and discharging valves for the water metering or batching system shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. Piping for water and for admixtures shall be free from leaks and shall be properly valved to prevent backflow or siphoning. Admixtures shall be furnished as a liquid of suitable concentration for easy control of dispensing. An adjustable, accurate, mechanical device for measuring and dispensing each admixture shall be provided. Each admixture dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and individually discharged automatically in a manner to obtain uniform distribution throughout the water as it is added to the batch in the specified mixing period. When use of truck mixers makes this requirement impractical, the admixture dispensers shall be interlocked with the sand batchers. Different admixtures shall not be combined prior to introduction in water and shall not be allowed to intermingle until in contact with the cement. Admixture dispensers shall have suitable devices to detect and indicate flow during dispensing or have a means for visual observation. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment, and for sampling and calibrating the dispensing of cementitious material, water, and admixtures. Filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

### 3.2.1.3 Scales

The weighing equipment shall conform to the applicable requirements of CPMB Concrete Plant Standard, and of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the specified frequency in the presence of a Government inspector. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials or indicators.

### 3.2.1.4 Batching Tolerances

#### (A) Tolerances with Weighing Equipment

<u>MATERIAL</u>	<u>PERCENT OF REQUIRED WEIGHT</u>
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

#### (B) Tolerances with Volumetric Equipment

For volumetric batching equipment used for water and admixtures, the following tolerances shall apply to the required volume of material being batched:

<u>MATERIAL</u>	<u>PERCENT OF REQUIRED MATERIAL</u>
Water:	plus or minus 1 percent
Chemical admixtures:	0 to plus 6 percent

### 3.2.1.5 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched.

### 3.2.1.6 Concrete Mixers

Mixers shall be stationary mixers or truck mixers. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

### 3.2.1.7 Stationary Mixers

Concrete plant mixers shall be drum-type mixers of tilting, nontilting, horizontal-shaft, or vertical-shaft type, or shall be pug mill type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94 applicable to central-mixed concrete.

### 3.2.1.8 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall

be equipped with two counters from which it is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Or, if approved in lieu of this, the number of revolutions shall be marked on the batch tickets. Water shall not be added at the placing site unless specifically approved; and in no case shall it exceed the specified w/c. Any such water shall be injected at the base of the mixer, not at the discharge end.

### 3.3 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in truck mixers, agitators, nonagitating transporting equipment conforming to NRMCA TMMB-01 or by approved pumping equipment or conveyors.

### 3.4 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

#### 3.4.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 0.2 square meters. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 1.5 cubic meters shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

#### 3.4.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

#### 3.4.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Nonagitating equipment shall be used only for transporting plant-mixed concrete over a smooth road and when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

### 3.4.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes normally attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

### 3.4.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means, such as discharge baffle or hopper, for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 900 mm. The belt speed shall be a minimum of 90 meters per minute and a maximum of 225 meters per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant truck that is long enough to extend through the reinforcing bars.

### 3.4.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 100 mm. Aluminum pipe shall not be used.

## 3.5 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 30 degrees C, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

### 3.5.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 1.5 meters except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 300 mm thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level. Concrete shall be deposited continuously in one layer or in layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. Concrete that has surface dried, partially

hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

### 3.5.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 100 mm thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.6 mm, and the head diameter shall be appropriate for the structural member and the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150 mm into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 100 mm and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Excessive vibration of lightweight concrete resulting in segregation or flotation of coarse aggregate shall be prevented. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

### 3.5.3 Cold Weather Requirements

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 5 degrees C. The temperature of the concrete when placed shall be not less than 10 degrees C nor more than 25 degrees C. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, an accelerating admixture conforming to ASTM C 494, Type C or E may be used, provided it contains no calcium chloride. Calcium chloride shall not be used.

### 3.5.4 Hot Weather Requirements

When the ambient temperature during concrete placing is expected to exceed 30 degrees C, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. A retarder may be used, as approved, to

facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 49 degrees C. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

#### Maximum Allowable Concrete Placing Temperature

<u>Relative Humidity, Percent, During Time of Concrete Placement</u>	<u>Maximum Allowable Concrete Temperature, Degrees</u>
Greater than 60	33 C
40-60	30 C
Less than 40	27 C

#### 3.5.5 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, as well as interior placements when space heaters produce low humidity, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

#### 3.5.6 Placing Flowable Concrete

If a plasticizing admixture conforming to ASTM C 1017 is used or if a Type F or G high range water reducing admixture is permitted to increase the slump, the concrete shall meet all requirements of paragraph GENERAL REQUIREMENTS in PART 1. Extreme care shall be used in conveying and placing the concrete to avoid segregation. Consolidation and finishing shall meet all requirements of paragraphs Placing Concrete, Finishing Formed Surfaces, and Finishing Unformed Surfaces. No relaxation of requirements to accommodate flowable concrete will be permitted.

#### 3.6 JOINTS

Joints shall be located and constructed as indicated or approved. Joints not indicated on the drawings shall be located and constructed to minimize the impact on the strength of the structure. In general, such joints shall be located near the middle of the spans of supported slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs, unless otherwise approved. Joints shall be perpendicular to the main reinforcement. All reinforcement shall be continued across joints; except that reinforcement or other fixed metal items shall not be continuous through expansion joints, or through construction or contraction joints in slabs on grade. Reinforcement shall be 50 mm clear from each joint. Except where otherwise indicated, construction joints between interior slabs on grade and

vertical surfaces shall consist of 1.5 kg per square meter asphalt-saturated felt, extending for the full depth of the slab. The perimeters of the slabs shall be free of fins, rough edges, spalling, or other unsightly appearance. Reservoir for sealant for construction and contraction joints in slabs shall be formed to the dimensions shown on the drawings by removing snap-out joint-forming inserts, by sawing sawable inserts, or by sawing to widen the top portion of sawed joints. Joints to be sealed shall be cleaned and sealed as indicated and in accordance with Section 07920 JOINT SEALING.

### 3.6.1 Construction Joints

For concrete other than slabs on grade, construction joints shall be located so that the unit of operation does not exceed **15 meters**. Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old. Construction joints shall be located as indicated or approved. For concrete other than slabs on grade, where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be located as indicated on the contract drawings and shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete begins to lose its plasticity, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints in walls or columns are required, a strip of 25 mm square-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 25 mm above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph Previously Placed Concrete.

### 3.6.2 Contraction Joints in Slabs on Grade

Contraction joints shall be located and detailed as shown on the drawings. Contraction Joints shall be produced by forming a weakened plane in the concrete slab by sawing a continuous slot with a concrete saw. The weakened plane shall be 1/4 the depth of the slab thickness and between 3 and 5 mm wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent ravelling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Reservoir for joint sealant shall be formed as previously specified.

### 3.6.3 Expansion Joints

Installation of expansion joints and sealing of these joints shall conform to the requirements of Section **0325903150** EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS and Section 07920 JOINT SEALING.

### 3.6.4 Waterstops



Waterstops shall be installed in conformance with the locations and details shown on the drawings using materials and procedures specified in Section 03250 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS.

### 3.6.5 Dowels

Dowels shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1 mm in 100 mm. Care shall be taken during placing adjacent to and around dowels to ensure there is no displacement of the dowel and that the concrete completely embeds the dowel and is thoroughly consolidated.

## 3.7 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A or B finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/A117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A and B Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

### 3.7.1 Class A Finish and Class B Finish

Class A finish is required for surfaces permanently exposed to public view that require excellent appearance at close range. Class B finish is required for surfaces exposed to public view that do not require the excellent appearance of Class A. Fins, ravelings, and loose material shall be removed, all surface defects over 12 mm in diameter or more than 12 mm deep, shall be repaired and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Defects more than 12 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep. The Contractor shall prepare a sample panel for approval (as specified in

PART 1) before commencing repair, showing that the surface texture and color match will be attained. Metal tools shall not be used to finish repairs in Class A surfaces.

### 3.7.2 Class C and Class D Finish

Class C finish is required for concealed surfaces not exposed to view and for all surfaces not covered by Class A, B, or D finish. Class D finish is required for surfaces where roughness and irregularities are not objectionable. Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 12 mm deep or more than 50 mm in diameter shall be repaired. Defects more than 50 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep.

## 3.8 REPAIRS

### 3.8.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 100 mm shall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the 1.18 mm sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

### 3.8.2 Repair of Major Defects

Major defects will be considered to be those more than 12 mm deep or, for Class A and B finishes, more than 12 mm in diameter and, for Class C and D finishes, more than 50 mm in diameter. Also included are any defects of any kind whose depth is over 100 mm or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

#### 3.8.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used. If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 50 mm on all sides. All such defective areas greater than 7800 square mm shall be outlined by saw cuts at least 25 mm deep. Defective areas less than 7800 square mm shall be outlined by a 25 mm deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours

immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

### 3.8.2.2 Repair of Deep and Large Defects

Deep and large defects will be those that are more than 150 mm (6 inches) deep and also have an average diameter at the surface more than 450 mm (18 inches) or that are otherwise so identified by the Project Office, or defects which affect the strength of the structure shall not be repaired and that portion of the structure shall be completely removed and replaced

## 3.9 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

### 3.9.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed shall be not less than 10 degrees C. In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or "jitterbugs" shall not be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of

the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 3.05 meter straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

#### 3.9.1.1 Rough-Slab Finish

Slabs shall be screeded with straight edges immediately after consolidation to bring the surface to the required finish level with no course aggregate visible.

#### 3.9.1.2 Float Finish

Slabs to receive more than a rough slab finish shall next be given a wood float finish. Slabs in the Support Areas (South of column line E) other than the mechanical room shall receive a float finish. The screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 7 mm and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand flats shall be made of wood, magnesium, or aluminum. Concrete that exhibits stickiness shall be floated with a magnesium float. Care shall be taken to prevent over-finishing or incorporating water into the surface.

#### 3.9.1.3 Troweled Finish

Slabs inside the magazines, work bays (North of column line E), and mechanical room shall be given a trowel finish. Coordinate preparation with conductive sparkproof resin manufacturer. After floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled 2-4 times, with waiting period between each, as approved. Care shall be taken to prevent blistering and if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

### 3.10 EXTERIOR SLAB AND RELATED ITEMS

#### 3.10.1 Pavements

Portland cement concrete pavements shall be constructed in accordance with Section 02754  
CONCRETE PAVEMENTS.

### 3.10.2 Sidewalks

Portland cement concrete sidewalks shall be constructed in accordance with SECTION: 02770,  
CONCRETE SIDEWALKS AND CURBS AND GUTTERS.

### 3.10.3 Curbs and Gutters

Portland cement concrete sidewalks shall be constructed in accordance with SECTION: 02770,  
CONCRETE SIDEWALKS AND CURBS AND GUTTERS.

### 3.10.4 Pits and Trenches

Pits and trenches shall be constructed as indicated on the drawings. Bottoms and walls shall be placed monolithically or waterstops and keys, shall be provided as approved.

## 3.11 CURING AND PROTECTION

### 3.11.1 General

Concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days
All other concrete	7 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water for the duration of the curing period. Air and forms in contact with concrete shall be maintained at a temperature above 10 degrees C for the first 3 days and at a temperature above 0 degrees C for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure, and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time. Except as otherwise permitted by paragraph Membrane Forming Curing Compounds, moist curing shall be provided for any areas to receive floor hardener, any paint or other applied coating, or to which other concrete is to be bonded. Concrete containing silica fume shall be initially cured by fog misting during finishing, followed immediately by continuous moist curing. Except for plastic coated burlap, impervious sheeting alone shall not be used for curing.

### 3.11.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. If water or curing materials used stain or discolor concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned as approved. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, nonsupporting vertical forms shall be broken loose from the concrete soon after the concrete hardens and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day.

### 3.11.3 Membrane Forming Curing Compounds

Concrete may be cured with a nonpigmented curing compound containing a fugitive dye in lieu of moist curing. Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, including surfaces to which a smooth finish is to be applied or other concrete to be bonded. However, a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements, may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 500 kPa, at a uniform coverage of not more than 10 cubic meters per L for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

### 3.11.4 Impervious Sheeting

Horizontal or near horizontal concrete surfaces may be cured using impervious sheets. However, except for plastic coated burlap, impervious sheeting alone shall not be used for curing. Impervious-sheet curing shall only be used on horizontal or nearly horizontal surfaces. Surfaces shall be thoroughly wetted and be completely covered with the sheeting. Sheeting shall be at least 450 mm wider than the concrete surface to be covered. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 300 mm and securely weighted down or shall be lapped not less than 100 mm and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it

remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

#### 3.11.5 Ponding or Immersion

Concrete shall be continually immersed throughout the curing period. Water shall not be more than 10 degrees C less than the temperature of the concrete.

#### 3.11.6 Cold Weather Curing and Protection

When the daily ambient low temperature is less than 0 degrees C the temperature of the concrete shall be maintained above 5 degrees C for the first seven days after placing. During the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 13 degrees C as determined by suitable temperature measuring devices furnished by the Government, as required, and installed adjacent to the concrete surface and 50 mm inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor as directed.

### 3.12 SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 20 mm. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed. Nonshrink grout shall be used for as approved.

#### 3.12.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

#### 3.12.2 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

##### 3.12.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 18 to 30 degrees C until after setting.

#### 3.12.2.2 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 25 mm and immediately covered with a parge coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall have a smooth-dense finish and be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

### 3.13 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall be onsite and shall conform with ASTM C 1077. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site. The Government may inspect the laboratory, equipment, and test procedures prior to start of concreting operations for conformance with ASTM C 1077.

#### 3.13.1 Grading and Corrective Action

##### 3.13.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

##### 3.13.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at



which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

### 3.13.2 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests for aggregate quality required by ASTM C 33. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality at least every three months, and when the source of aggregate or aggregate quality changes. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

### 3.13.3 Scales, Batching and Recording

The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three months. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. At the same time, the Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

### 3.13.4 Batch-Plant Control

The measurement of concrete materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic meter, (cubic yard,) amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic meter (cubic yard) for each class of concrete batched during each day's plant operation.

### 3.13.5 Concrete Mixture

a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each

separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231 for normal weight concrete and ASTM C 173 for lightweight concrete. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted.

c. Slump Testing. In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture. The upper warning limit shall be set at 12.5 mm below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump

test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 50 mm. Samples for slump shall be taken at the mixer. However, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an adjustment shall immediately be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c ratio specified, based on aggregates which are in a saturated surface dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted, and the Contractor shall take appropriate steps to bring the slump under control. Additional slump tests shall be made as directed.

e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.

f. Strength Specimens. At least one set of test specimens shall be made, for compressive or flexural strength as appropriate, on each different concrete mixture placed during the day for each 250 cubic meters or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph Strength Requirements in PART 1 shall consist of four specimens, two to be tested at 7 days and two at 28 days. Test specimens shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39 for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R.

### 3.13.6 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

### 3.13.7 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

### 3.13.8 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately removed from service and repaired or replaced.

### 3.13.9 Curing Inspection

a. Moist Curing Inspections. At least once each shift, and not less than twice per day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

b. Moist Curing Corrective Action. When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by 1 day.

c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, the Contractor shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, shall compute the rate of coverage in square meters per Liter, and shall note whether or not coverage is uniform.

d. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

e. Sheet Curing Inspection. At least once each shift and once per day on non-work days, an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

f. Sheet Curing Corrective Action. When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the

sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

#### 3.13.10 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

#### 3.13.11 Mixer Uniformity

a. Stationary Mixers. Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 60,000 cubic meters of concrete placed, whichever results in the shortest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94.

b. Truck Mixers. Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

#### 3.13.12 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

END OF SECTION

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## SECTION 07416

### STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

#### PART 1 GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

#### ALUMINUM ASSOCIATION (AA)

AA-02 (1994) Aluminum Design Manual: Specifications and Guidelines for Aluminum Structures

#### AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC-04 (1989) Specification for Structural Steel Buildings – Allowable Stress Design, Plastic Design

#### AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI-01 (1986; Addenda 1989) Cold-Formed Steel Design Manual

#### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463 (1996a) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

ASTM A 653 (1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 792 (1995) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

ASTM B 117 (1994) Operating Salt Spray (Fog) Testing Apparatus

ASTM B 209 (1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM C 518 (1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM C 991 (1992) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings

ASTM C 1289 (1995) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board

ASTM D 522 (1993a) Mandrel Bend Test of Attached Organic Coatings

ASTM D 523	(1989; R 1994) Specular Gloss
ASTM D 714	(1987; R 1994) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1993) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1993) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1994) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1995) Measuring Adhesion by Tape Test
ASTM D 4214	(1989) Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water-Exposure Apparatus
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 1592	(1995) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)	
ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures
METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)	
MBMA-01	(1996) Low Rise Building Systems Manual



## STEEL JOIST INSTITUTE (SJI)

SJI-01 (1994) Standard Specifications Load Tables and Weight  
Tables for Steel Joists and Joist Girders

### 1.2 GENERAL REQUIREMENTS

The Contractor shall furnish a manufacturer's standard product which satisfies all requirements contained herein and has been verified by load testing and independent design analyses to meet the specified design requirements.

#### 1.2.1 Manufacturer

The SSSMR system shall be the product of a manufacturer who has been in the practice of manufacturing SSSMR systems for a period of not less than 5 years and has been involved in at least five projects similar in size and complexity to this project.

#### 1.2.2 Installer

The installer shall be certified by the SSSMR system manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

### 1.3 DESIGN REQUIREMENTS

The design of the SSSMR system shall be provided by the Contractor as a complete system. Members and connections not indicated on the drawings shall be designed by the Contractor. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same manufacturer.

#### 1.3.1 Design Criteria

Design criteria shall be in accordance with ASCE 7 unless otherwise specified.

#### 1.3.2 Dead Loads

The dead load shall be the weight of the SSSMR system. Collateral loads such as sprinklers, mechanical and electrical systems, and ceilings shall not be attached to the panels.

#### 1.3.3 Live Loads

##### 1.3.3.1 Concentrated Loads

The panels and anchor clips shall be capable of supporting a 1335 N (300 pound) concentrated load. The concentrated load shall be applied at the panel midspan and will be resisted by a single standing seam metal roof panel assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

### 1.3.3.2 Uniform Loads

The panels and concealed anchor clips shall be capable of supporting a minimum uniform live load of 960 Pa. (20 psf).

### 1.3.4 Roof Snow Loads

The design roof snow loads shall be as shown on the contract drawings.

### 1.3.5 Wind Loads

The design wind uplift pressure for the roof system shall be as shown on the contract drawings. The design uplift force for each connection assembly shall be that pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly. The safety factor listed below shall be applied to the design force and compared against the ultimate capacity. Prying shall be considered when figuring fastener design loads.

- a. Single fastener in each connection.....3.0
- b. Two or more fasteners in each connection...2.25

### 1.3.6 Thermal Loads

Roof panels shall be free to move in response to the expansion and contraction forces resulting from a total temperature range of 27.7 degrees C (82 degrees F) during the life of the structure.

### 1.3.7 Framing Members Supporting the SSSMR System

Any additions/revisions to framing members supporting the SSSMR system to accommodate the manufacturer/fabricator's design shall be the Contractor's responsibility and shall be submitted for review and approval. New or revised framing members and their connections shall be designed in accordance with [AISC-04,] [AISI-01 or] [SJI-01], as applicable. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180 of the span length.

### 1.3.8 Roof Panels Design

Steel panels shall be designed in accordance with AISI-01. Aluminum panels shall be designed in accordance with AA-02. The structural section properties used in the design of the panels shall be determined using the unloaded shape of the roof panels. The calculated panel deflection from concentrated loads shall not exceed 1/180 of the span length. The calculated panel deflection under applied live load, snow, or wind load shall not exceed 1/180 times the span length. Deflections shall be based on panels being continuous across three or more supports. Deflection shall be calculated and measured along the major ribs of the panels.

### 1.3.9 Accessories and Their Fasteners

Accessories and their fasteners shall be capable of resisting the specified design wind uplift forces and shall allow for thermal movement of the roof panel system. Exposed fasteners shall not restrict free movement of the roof panel system resulting from thermal forces. There shall be a minimum of two fasteners per clip. Single fasteners with a minimum diameter of 9 mm (3/8 inch) will be allowed when the supporting structural members are prepunched or predrilled.

## 1.4 PERFORMANCE REQUIREMENTS

The SSSMR shall be tested for wind uplift resistance in accordance with ASTM E 1592; SSSMR systems previously tested and approved by the Corps of Engineers' STANDARD TEST METHOD FOR STRUCTURAL PERFORMANCE OF SSMRS BY UNIFORM STATIC AIR PRESSURE DIFFERENCE may be acceptable. Two tests shall be performed. Test 1 shall simulate the edge condition with one end having crosswise restraint and other end free of crosswise restraint. The maximum span length for the edge condition shall be 750 mm (30 inches). Test 2 shall simulate the interior condition with both ends free of crosswise restraint. The maximum span length for the interior condition shall be 1.5 m (5.0 feet). External reinforcement, such as clamps on the ribs, shall not be installed to improve uplift resistance. Bolts through seams shall not be installed.

## 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### Data

Design Analysis; GED.

Design analysis signed by a Registered Professional Engineer employed by the SSSMR manufacturer. The design analysis shall include a list of the design loads, and complete calculations for the support system (when provided by the Contractor), roofing system and its components; valley designs, gutter/downspout calculations, screw pullout test results, and shall indicate how expected thermal movements are accommodated.

### Drawings

Structural Standing Seam Metal Roof System; GED.

Metal roofing drawings and specifications and erection drawings; shop coating and finishing specifications; and other data as necessary to clearly describe design, materials, sizes, layouts, standing seam configuration, construction details, provisions for thermal movement, line of panel fixity, fastener sizes and spacings, sealants and erection procedures. Drawings shall reflect the intent of the architectural detailing using the manufacturer's proprietary products and fabricated items as required. The SSSMR system shop drawings shall be provided by the metal roofing manufacturer.

### Statements

Qualifications;.

Qualifications of the manufacturer and installer.

### Reports

Test Report for Uplift Resistance of the SSSMR;

The report shall include the following information:

- a. Details of the SSSMR system showing the roof panel cross-section with dimensions and thickness.
- b. Details of the anchor clip, dimensions, and thickness.
- c. Type of fasteners, size, and the number required for each connection.
- d. Purlins/subpurlins size and spacing used in the test.
- e. Description of the seaming operation including equipment used.
- f. Maximum allowable uplift pressures. These pressures are determined from the ultimate load divided by a factor of safety equal to 1.65.
- g. Any additional information required to identify the SSSMR system tested.
- h. Signature and seal of an independent registered engineer who witnessed the test.

#### Certificates

##### Structural Standing Seam Metal Roof System;

- a. Certification that the actual thickness of uncoated sheets used in SSSMRS components including roofing panels, subpurlins, and concealed anchor clips complies with specified requirements.
- b. Certification that materials used in the installation are mill certified.
- c. Previous certification of SSSMR system tested under the Corps of Engineers' Standard Test Method in lieu of ASTM E 1592 testing.
- d. Certification that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than three pieces has been tested and has met the quality standards specified for factory color finish.
- e. Certification of installer.
- f. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Structural Standing Seam Metal Roof (SSSMR) System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material Warranties.

##### Insulation;

Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

##### Roof Panels;

One piece of each type to be used, 225 mm (9 inches) long, full width.

##### Factory Color Finish;

Three 75 by 125 mm (3 by 5 inches) samples of each type and color.

#### Fasteners;

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

#### Insulation;

One piece, 300 by 300 mm (12 by 12 inches), of each type and thickness to be used, with a label indicating the rated permeance (if faced) and R-values. The flame spread, and smoke developed rating shall be shown on the label or provided in a letter of certification.

#### Gaskets and Insulating Compounds;

Two samples of each type to be used and descriptive data.

#### Sealant;

One sample, approximately 0.5 kg (1 pound), and descriptive data.

#### Concealed Anchor Clips;

Two samples of each type used.

#### Subpurlins;

One piece, 225 mm (9 inches) long.

#### EPDM Rubber Boots;

One piece of each type.

### 1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry. Storage conditions shall provide good air circulation and protection from surface staining.

### 1.7 WARRANTIES

The SSSMR system shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

#### 1.7.1 Contractor's Weathertightness Warranty

The SSSMR system shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by ordinary exposure to the elements and service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty shall include the entire roofing system including, but not limited to, the following: panel seams and joint, all accessories,

components and trim; penetrations such as vents, curbs, and skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed to provide a weathertight roof system; and items specified in other sections of these specifications that become part of the structural standing seam metal roof system. All material and workmanship deficiencies, system deterioration caused by ordinary exposure to the elements and service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor may supplement this warranty with written warranties from the installer and/or manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached example WARRANTY FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM, and shall start upon final acceptance of the facility or the date the Government takes possession, whichever is earlier. It shall be understood that the Contractor's Performance Bond will remain effective throughout the five year Contractor's warranty period for the entire SSSMR system as outlined above.

#### 1.7.2 Manufacturer's Material Warranties.

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all SSSMR system components such as roof panels, anchor clips and fasteners, flashing, accessories, and trim, fabricated from coil material:

- a. A manufacturer's 20 year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.
- b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change color in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing with an air-drying version of the specified finish or replacing the defective coated material.

## PART 2 PRODUCTS

### 2.1 ROOF PANELS

Panels shall be steel or aluminum and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 9 m. (30 feet). When length of run exceeds 9 m (30 feet) and panel laps are provided, each sheet in the run shall extend over three or more supports. Width of sheets shall provide not more than 600 mm (24 inches) of coverage in place. SSSMR system with roofing panels greater than 300 mm (12 inches) in width shall have standing seams rolled during installation by an electrically driven seaming machine. Height of standing seams shall be not less than 38 mm (1-1/2 inches).

#### 2.1.1 Steel Panels

Steel panels shall be zinc-coated steel conforming to ASTM A 653; aluminum-zinc alloy coated steel conforming to ASTM A 792, AZ 55 coating; or aluminum-coated steel conforming to ASTM A 463, Type 2, coating designation T2 65. Uncoated panels shall be 0.6 mm (0.0239 inch) thick minimum. Panels shall be within 95 percent of tested thickness. Prior to shipment, mill finish panels shall be treated with a passivating chemical to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

#### 2.1.2 Aluminum Panels

Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.8 mm (0.032 inch) thick.

### 2.2 CONCEALED ANCHOR CLIPS

Concealed anchor clips shall be the same as the tested roofing system. Clip bases shall have factory punched or drilled holes for attachment. Clips shall be made from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Single piece clips may be acceptable when the manufacturer can substantiate that the system can accommodate the thermal cyclic movement under sustained live or snow loads.

### 2.3 ACCESSORIES

Flashing, trim, metal closure strips, caps and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the panels and shall not absorb or retain water. Die cast metal closures shall be installed with double bead tape sealant and fasteners that stitch the panel to a 2 mm (16 gage) preformed backer plate to ensure a positive compression of the tape sealant. The use of a continuous angle butted to the panel ends to form a closure will not be allowed.

### 2.4 FASTENERS

Fasteners for steel roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum roof panels shall be aluminum or corrosion resisting steel. Fasteners for structural connections shall provide both tensile and shear ultimate strengths of not less than 3340 N (750 pounds) per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be sealed or have sealed washers on the exterior side of the roof to waterproof the fastener penetration. Washer material shall be compatible with the roofing; have a minimum diameter of 10 mm (3/8 inch) for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 3 mm (1/8 inch) thick. Exposed fasteners for factory color finished panels shall be factory finished to match the color of the panels.

#### 2.4.1 Screws

Screws for attaching anchor devices shall be not less than No. 14. Actual screw pull out test results shall be performed for the actual material gage and yield strength of the structural purlins or subpurlins to which the clip is to be anchored/attached. Other screws shall be as recommended by the manufacturer to meet the strength design requirements of the panels.

#### 2.4.2 Bolts

Bolts shall be not less than 6 mm (1/4 inch) diameter, shouldered or plain shank as required, with locking washers and nuts.

#### 2.4.3 Structural Blind Fasteners

Blind screw-type expandable fasteners shall be not less than 6 mm (1/4 inch) diameter. Blind (pop) rivets shall be not less than 7 mm (9/32 inch) minimum diameter.

### 2.5 SUBPURLINS

Cold formed supporting structural members/subpurlins shall have a minimum thickness of 1.5 mm (0.059 inches) and a minimum tensile yield strength of 345 MPa. (50000 psi.) Hot rolled structural members shall have a minimum thickness of 6 mm (0.25 inches) and a minimum tensile yield strength of 248 MPa. (36000 psi). Subpurlins shall be galvanized or given one coat of shop paint.

### 2.6 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated on the drawings. The exterior coating shall be a nominal 0.050 mm 2 mil thickness consisting of a topcoat of not less than 0.018 mm (0.7 mil) dry film thickness and the paint manufacturer's recommended primer of not less than 0.025 mm 1.0 mil thickness. The interior color finish shall consist of the same coating and dry film thickness as the exterior. The exterior color finish shall meet the test requirements specified below.

#### 2.6.1 Salt Spray Test

A sample of the sheets shall withstand a salt spray test for a minimum of 1000 hours in accordance with ASTM B 117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of 10, no blistering, as determined by ASTM D 714; and a rating of 8, 1 mm (1/32 inch) failure at scribe, as determined by ASTM D 1654.

#### 2.6.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 3 mm (1/8 inch) diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

#### 2.6.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition B for 1000 total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D



3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

#### 2.6.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

#### 2.6.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 13 mm 0.500 inch diameter hemispherical head indenter, equal to 6.7 times the metal thickness in mm, expressed in Newton-meters, 1.5 times the metal thickness in mils, expressed in inch-pounds, with no loss of adhesion.

#### 2.6.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 80 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

#### 2.6.7 Specular Gloss

Finished roof surfaces shall have a specular gloss value of 30 plus or minus at 60 degrees when measured in accordance with ASTM D 523.

#### 2.6.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

### 2.7 INSULATION

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 24 degrees C 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Blanket insulation shall have a facing as specified in paragraph VAPOR RETARDER. Insulation, including facings, shall have a flame spread not in excess of 25 and a smoke developed rating not in excess of 50 when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory.

#### 2.7.1 Polyisocyanurate Rigid Board Insulation for Use Above a Roof Deck

Polyisocyanurate insulation shall conform to ASTM C 1289, Type II, Class 1 (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For polyisocyanurate the maximum design R-value per 25 mm (1 inch) of insulation used shall be 1.27. Facings shall be non-asphaltic, glass fiber reinforced.

## 2.7.2 Blanket Insulation

Blanket insulation shall conform to ASTM C 991.

## 2.8 INSULATION RETAINERS

Insulation retainers shall be type, size, and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

## 2.9 SEALANT

Sealants shall be elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

## 2.10 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

## 2.11 VAPOR RETARDER

### 2.11.1 Vapor Retarders as Integral Facing

Insulation facing shall have a permeability of 1.15 ng per Pa-second-square meter (0.02 perm) or less when tested in accordance with ASTM E 96. Facing shall be white or reinforced foil with a vinyl finish. Facings and finishes shall be factory applied.

## 2.12 EPDM RUBBER BOOTS

Flashing devices around pipe penetrations shall be flexible, one-piece devices molded from weather-resistant EPDM rubber. Rubber boot material shall be as recommended by the manufacturer. The boots shall have base rings made of aluminum or corrosion resisting steel that conform to the contours of the roof panel to form a weather-tight seal.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Molded closure strips shall be installed wherever roofing sheets terminate in open-end configurations, exclusive of flashings. The closure strip

installation shall be weather-tight and sealed. Screws shall be installed with a clutching screw gun, to assure screws are not stripped. Field test shall be conducted on each gun prior to starting installation and periodically thereafter to assure it is adjusted properly to install particular type and size of screw as recommended by manufacturer's literature. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

#### 3.1.1 Field Forming of Panels

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's representative. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

#### 3.1.2 Subpurlins

Unless otherwise shown, subpurlins shall be anchored to the purlins or other structural framing members with bolts or screws. Attachment to the substrate (when provided) or to the panels is not permitted. The subpurlin spacing shall not exceed 750 mm (30 inches) on centers at the corner, edge and ridge zones, and 1500 mm (5 foot) maximum on centers for the remainder of the roof. Corner, edge, and ridge zones are as defined in ASCE 7.

#### 3.1.3 Roof Panel Installation

Roof panels shall be installed with the standing seams in the direction of the roof slope. The side seam connections for installed panels shall be completed at the end of each day's work. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weather-tight installation. End laps of panels shall be provided in accordance with the manufacturer's instructions. Closures, flashings, EPDM rubber boots, roof curbs, and related accessories shall be installed according to the manufacturer's drawings. Fasteners shall not puncture roofing sheets except as provided for in the manufacturer's instructions for erection and installation. Expansion joints for the standing seam roof system shall be installed at locations indicated on the contract drawings and other locations indicated on the manufacturer's drawings.

#### 3.1.4 Concealed Anchor Clips

Concealed anchor clips shall be fastened directly to the structural framing members. Attachment to the substrate (when provided) or to the panels is not permitted. The maximum distance, parallel to the seams, between clips shall be 750 mm (30 inches) on center at the corner, edge, and ridge zones, and 1500 mm (5 feet) maximum on centers for the remainder of the roof.

### 3.2 INSULATION INSTALLATION

Insulation shall be continuous over entire roof surface. Where expansion joints, terminations, and other connections are made, the cavity shall be filled with batt insulation with vapor retarder providing equivalent R-value and perm rating as remaining insulation. Insulation shall be installed as indicated and in accordance with manufacturer's instructions.

### 3.2.1 Board Insulation with Blanket Insulation

Rigid or semirigid board insulation shall be laid in close contact. Board shall be attached to the metal roof deck with bearing plates and fasteners, as recommended by the insulation manufacturer, so that the insulation joints are held tight against each other, and shall have a minimum of 1 fastener per 0.37 square meters (4 fasteners per square foot). Layout and joint pattern of insulation and fasteners shall be indicated on the shop drawings. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer. A layer of blanket insulation shall be placed over the rigid or semirigid board insulation to be compressed against the underside of the metal roofing to reduce thermal bridging, dampen noise, and prevent roofing flutter. This layer of blanket insulation shall be compressed a minimum of 50 percent.

### 3.2.2 Blanket Insulation

Blanket insulation shall be installed between and parallel to the purlins with tabs of a facer lapping on the top face of the purlins. Thermal blocks shall be provided over purlins, between clips. A second layer of unfaced insulation shall be added between purlins to provide full R-value. Blanket insulation shall be supported by an integral facing or other commercially available support system.

## 3.3 PROTECTION OF VAPOR RETARDER FROM ROOF DECK

A cloth industrial duct tape shall be applied over the seams of metal roof decks, at penetration edges, and at surface areas exhibiting sharp burrs or similar protrusions. For other types of roof decks, cloth industrial duct tape shall be applied over irregularities which could potentially puncture polyethylene membrane.

## 3.4 VAPOR RETARDER INSTALLATION

### 3.4.1 Integral Facing on Blanket Insulation

Integral facing on blanket insulation shall have the facing lapped and sealed with a compatible tape to provide a vapor tight membrane.

### 3.4.2 Polyethylene Vapor Retarder

The polyethylene vapor retarder membrane shall be installed over the entire surface. A fully compatible polyethylene tape shall be used to seal the edges of the sheets to provide a vapor tight membrane. Sheet edges shall be lapped not less than 150 mm. 6 inches. Sufficient material shall be provided to avoid inducing stresses in the sheets due to stretching or binding. All tears or punctures that are visible in the finished surface at any time during the construction process shall be sealed with polyethylene tape.

## 3.5 SLIP SHEET INSTALLATION

A slip sheet shall be laid over the blanket insulation facing to prevent the vinyl facing from adhering to the metal roofing.

### 3.6 CLEANING AND TOUCH-UP

Exposed SSSMR systems shall be cleaned at completion of installation. Debris that could cause discoloration and harm to the panels, flashings, closures and other accessories shall be removed. Grease and oil films, excess sealants, and handling marks shall be removed and the work shall be scrubbed clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, and solder or weld marks. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Factory color finished surfaces shall be touched up with the manufacturer's recommended touch up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

PROJECT DESCRIPTION AND LOCATION (Include Bldg.  
no.): \_\_\_\_\_ CORPS OF ENGINEERS CONTRACT  
NUMBER: \_\_\_\_\_ SPECIFICATION SECTION  
NUMBER & DESCRIPTION: 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

CONTRACTOR: \_\_\_\_\_  
ADDRESS: \_\_\_\_\_ POINT OF  
CONTACT: \_\_\_\_\_  
TELEPHONE NUMBER: \_\_\_\_\_  
OWNER: \_\_\_\_\_  
ADDRESS: \_\_\_\_\_  
POINT OF CONTACT: \_\_\_\_\_  
TELEPHONE NUMBER: \_\_\_\_\_

CONSTRUCTION AGENT: \_\_\_\_\_  
ADDRESS: \_\_\_\_\_  
POINT OF CONTACT: \_\_\_\_\_  
TELEPHONE NUMBER: \_\_\_\_\_

THE SSSMR SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY  
\_\_\_\_\_ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP  
AND MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE. THE  
SSSMR SYSTEM  
COVERED UNDER THIS WARRANTY SHALL INCLUDE THE ENTIRE ROOFING SYSTEM, INCLUDING  
THE STANDING SEAM METAL ROOF PANELS, PANEL FINISHES, ROOFING SECUREMENT  
COMPONENTS, ALL ACCESSORIES, COMPONENTS, AND TRIM; INCLUDING PENETRATIONS SUCH  
VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES,  
RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS  
INSTALLED TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER  
SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE SSSMR SYSTEM. ALL LEAKS  
SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL  
COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR,  
AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF  
FINAL ACCEPTANCE ON \_\_\_\_\_ AND WILL REMAIN IN EFFECT FOR  
STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

\_\_\_\_\_  
(Company President) (Date)

(SEE REVERSE SIDE FOR SUPPLEMENTAL PROVISIONS AND EXCLUSIONS)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
(continued)

THE CONTRACTOR MAY SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE INSTALLER AND/OR MANUFACTURER OF THE SSSMR SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THE WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

#### EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).
2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.
3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.
4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.
5. FAILURE OF ANY PART OF THE SSSMR SYSTEM DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE FROM THE ROOF AND ALLOW PONDING WATER. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.
6. THIS WARRANTY APPLIES TO THE STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.
7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES, UNLESS OTHERWISE APPROVED IN WRITING BY THE CONTRACTING OFFICER.

LEAKS SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE SSSMR SYSTEM REPAIRED OR REPAIRED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

END OF SECTION



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## SECTION 15566

### WARM AIR HEATING SYSTEMS

#### PART 1 GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

#### AIR DIFFUSION COUNCIL (ADC)

ADC 1062:GRD (1984) Test Codes for Grilles, Registers, and Diffusers

#### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.47 (1998) Gas-Fired Furnaces

ANSI Z21.66 (1996) Automatic Vent Damper Devices for Use with Gas-Fired Appliances

#### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M (1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 123/A 123M (1997a<sup>el</sup>) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 653/A 653M (1999a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

ASTM D 520 (1984; R 1995<sup>el</sup>) Zinc Dust Pigment

ASTM D 1654 (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D 1784 (1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D 3359 (1997) Measuring Adhesion by Tape Test

ASTM F 872 (1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type, Cleanable

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE 52.1 (1992) Gravimetric and Dust-Spot Procedures for  
Testing Air-Cleaning Devices Used in General  
Ventilation for Removing Particulate Matter

INTERNATIONAL APPROVAL SERVICES (IAS)

IAS Directory (1998) IAS Directory of AGA & CGA Certified  
Appliances and Accessories

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (1998) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31 (1997; TIA 97-1) Installation of Oil Burning Equipment

NFPA 54 (1999) National Fuel Gas Code

NFPA 90A (1999) Installation of Air Conditioning and Ventilating  
Systems

NFPA 90B (1999) Installation of Warm Air Heating and Air  
Conditioning Systems

NFPA 211 (200) Chimneys, Fireplaces, Vents, and Solid Fuel-  
Burning Appliances

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH115 (1993) Fibrous Glass Duct Construction Standards

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL  
ASSOCIATION (SMACNA)

SMACNA HVAC Duct Const Stds (1995; Addenda Nov 1997)) HVAC Duct Construction  
Standards - Metal and Flexible

SMACNA Install Fire Damp HVAC (1992) Fire, Smoke and Radiation Damper Installation  
Guide for HVAC Systems

SMACNA Leakage Test Mnl (1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL 181 (1996; Rev Dec 1998) Factory-Made Air Ducts and Air  
Connectors

UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 296	(1994; Rev Sep 1998) Oil Burners
UL 441 Gas Vents	(1996; Rev Dec 1999)
UL 555	(1999) Fire Dampers
UL 641	(1995; Rev Apr 1999) Type L, Low-Temperature Venting Systems
UL 727	(1994; Rev thru Jan 1999) Oil Fired Central Furnaces
UL 900	(1994; Rev thru Nov 1999) Test Performance of Air Filter Units
UL 1738	(1993; Rev thru Mar 1998) Venting Systems for Gas-Burning Appliances, Categories II, III and IV
UL Bld Mat Dir	(1999) Building Materials Directory
UL Elec Const Dir	(1999) Electrical Construction Equipment Directory
UL Fire Resist Dir	(1999) Fire Resistance Directory

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### Shop Drawings

Heating Equipment; FIO  
Installation; GA

Drawings shall consist of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Drawings shall contain complete equipment wiring diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenance and equipment relationship to other parts of the work including clearances required for maintenance and operation.

## Product Data

### Heating Equipment; GA

Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 12 months operation, and a list of the parts recommended by the manufacturer to be replaced after ~~{1} and {3}~~ year~~(s)~~ of service. |

### Tests; GA

Proposed test procedures for ductwork leak and performance tests, at least 2 weeks prior to the start of related testing.

### System Diagrams; FIO

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

### Similar Services; FIO

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

### Tests; FIO

Proposed test schedules for ductwork leak test and performance tests, at least 2 weeks prior to the start of related testing.

### Field Training; FIO

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

## Test Reports

### Tests; GA

Test reports for the ductwork leak test and the performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

## Operation and Maintenance Data

### Heating Equipment; GA

Six manuals listing step-by-step procedures required for system startup, operation, shutdown and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tool that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

## 1.3 GENERAL REQUIREMENTS

### 1.3.1 Standard Products

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

### 1.3.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment.

### 1.3.3 Verification of Dimensions

After becoming familiar with all details of the work and working conditions, the Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing any work.

## 1.4 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

## 1.5 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 746 W (1 hp) and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be in accordance with NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state

variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 7.45 kW (10 hp) or less. Adjustable frequency drives shall be used for larger motors.

## PART 2 PRODUCTS

### 2.1 SELF-CONTAINED FURNACE

Furnace shall be a manufacturer's standard, self-contained, forced circulated air heating type furnace as indicated. Furnace and furnace components shall be completely factory-assembled and wired. Furnace casing shall be factory insulated and be compatible with the operating temperatures. Furnace shall be provided with removable service panels which allow access to all internal components requiring cleaning, servicing, or adjustment.

### 2.2 FURNACE COMPONENTS

#### 2.2.1 Supply Blowers

Blowers shall be centrifugal type. Blowers shall be statically and dynamically balanced. Lubrication points shall be located or extended, as required, to provide ready access for periodic lubrication. The direction of rotation shall be clearly and permanently marked on each blower housing. Blower speeds shall be single, or multispeed, as indicated, to provide the specified range of air temperature rises. Direct-drive blowers may have multiple speed motors to change blower speed. Belt-drive blowers shall be provided with an adjustable base and guard or enclosed in the unit casing. The belt drive shall be designed in accordance with the applicable Rubber Manufacturer's Association (RMA) power transmission belt specifications, with a service factor of at least 1.2. Shafts shall be supported by a minimum of two self-aligning bearings. Blower speed shall be adjusted by the use of variable pitch drive sheaves.

### 2.3 AIR CONDITIONING EQUIPMENT

Cooling coils, condensers and related equipment shall be as specified in Section 15653 AIR-CONDITIONING SYSTEM (UNITARY TYPE).

### 2.4 CONTROLS

Furnace controls shall be provided by the furnace manufacturer as an integral part of the furnace. Electronic controls shall be provided. The controls shall allow for single stage two stage operation. Controls shall be provided as specified in Section ~~15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS~~ 15951 DIRECT DIGITAL CONTROL FOPR HVAC.

### 2.6 NOT USED

### 2.7 AIR FILTERS

Air Filters shall be listed in accordance with requirements of UL 900.



### 2.7.1 Replaceable Media filters

Replaceable media filters shall be the ~~[dry-media]~~ ~~[viscous-adhesive]~~ type, of the size required to suit the application. Filtering media shall be not less than 50 mm (2 inches) 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 1.6 mm (16 gauge) 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not exceeding 1.5 m/s (300 feet per minute), with initial resistance of 32 Pa (0.13 inches water gauge). Average efficiency shall be not less than 65 percent when tested according to ASHRAE 52.1.

## 2.8 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 653/A 653M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphated and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint in accordance with ASTM D 520, Type I.

## PART 3 EXECUTION

### 3.1 INSTALLATION

The warm air heating installation shall conform to the requirements contained in NFPA 90A or NFPA 90~~BA~~, as applicable. ~~Combustion air supply and ventilation shall be in accordance with [NFPA 31] or [NFPA 54].~~

#### 3.1.1 Furnaces

Foundations, settings, or suspensions for mounting equipment and accessories including supports, vibration isolators, stands, guides, anchors, clamps, and brackets shall be provided. Foundations and suspension for equipment shall conform to the recommendations of the manufacturer, unless otherwise indicated on drawings. Anchor bolts and sleeves shall be set accurately using properly constructed templates. Anchor bolts, when embedded in concrete, shall be provided with welded-on plates on the head end and guarded against damage until equipment is installed. Equipment bases shall be leveled, using jacks or steel wedges, and when resting on concrete shall be neatly grouted-in with a nonshrinking type of grout. Equipment shall be located as indicated and in such a manner that working space is available for all necessary servicing, such as shaft removal, replacing, or adjusting drives, motors, or shaft seals, air filters, access to automatic controls, humidifiers, and lubrication. Electrical isolation shall be provided between dissimilar metals for the purpose of minimizing galvanic corrosion. The interior of cabinets or casings shall be cleaned before completion of installation. The furnace shall be connected to the vent or chimney with the specified connectors, draft regulators, draft loads, and induced draft fans, as applicable, in accordance with NFPA 211.

### 3.1.4 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and so located that the concealed items may be serviced and maintained or completely removed for replacement. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

### 3.1.5 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

### 3.1.6 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

### 3.1.7 Metal Ductwork

Installation shall be in accordance with SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be in accordance with SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided. Where threaded rods are used, they not be formed or bent.

### 3.1.9 Air Filters

Air filters shall be installed in heater casings and in return air duct. Fans or blowers shall not be operated until filters are installed. After completion of tests and before the building is accepted by the Government, the Contractor shall [furnish a new second set of replaceable filters.

### 3.1.10 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

### 3.1.11 Insulation

Thickness and application of insulation materials for ductwork and equipment shall be in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 3.1.12 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

## 3.2 FIELD PAINTING

Finish painting of items only primed at the factory or surfaces not specifically noted, otherwise are specified in Section 09900 PAINTING, GENERAL.

## 3.3 CLEANING

Ducts, plenums, and casings shall be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. All equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

## 3.4 TESTS

Upon completion and prior to acceptance of the installation, the Contractor shall furnish all equipment, instruments, materials, labor, and supervision required for the tests as specified. Water, electricity required for testing will be furnished by the Government. Defects disclosed by the tests shall be rectified. Tests shall be made under the direction and subject to the approval of the Contracting Officer. All indicating instruments shall be read at 1/2-hour intervals unless otherwise directed by the Contracting Officer.

### 3.4.1 Not Used

### 3.4.2 Testing, Adjusting, and Balancing

Testing, adjusting, and balancing shall be as specified in SECTION 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

### 3.4.3 Performance Tests

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be conducted by an experienced engineer. Tests shall cover a period of not less than 2 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity in a shaded and weather protected area.

### 3.5 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 40 hours of normal working time shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved operating and maintenance instructions.

END OF SECTION

## SECTION 16740

### TELEPHONE SYSTEM

#### PART I - GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. As publications are revised and reissued the latest version of these standards take precedence over older versions.

##### Safety

NFPA (National Fire Protection Association) National Electric Code-1996 NEC-1996)

NFPA-70                                      National Electric Code (ANSI C2)

UL    (Underwriters Laboratories)

UL 444,                                      Standard for safety, Communications Cables

UL 497,                                      Standard for safety, Protectors for communications circuits

UL 497A,                                    Standard for Safety, Secondary Protectors for Communications Circuits

UL 497B,                                    Standard for Safety, Protectors for Data Communications and Fire Alarm Circuits

UL 1459,                                    Standard for Safety, Telephone Equipment

UL 1863,                                    Standard for Safety, Communication circuit Accessories

##### Harm to the Telephone Network

Title 47, Code of Federal Regulations, Part 68

Docket 88-57

##### Performance of Networks

IEEE    Institute of Electrical and Electronic Engineers

ANSI/IEEE                                    Carrier Sense Multiple Access with Collision  
Standard 802.3                                Detection {Ethernet & 10BASE-T}

ANSI/IEEE                                    Token Ring Access Method {Token Ring}  
Standard 802.5

## Performance of Wiring Systems

TIA	(Telecommunications Industry Association)
EIA/TIA-568A	Commercial Building Telecommunications Cabling Astandard
EIA/TIA-569,	Commercial Building Standard for Telecommunications Pathways and Spaces
EIA/TIA-570,	Residential and Light Commercial Telecommunications Wiring Standard
TIA/EIA-606,	Administration Standard for the telecommunications Infrastructure of Commercial Buildings
TIA/EIA-607,	Commercial Building Grounding & Bonding Requirements for Telecommunications
TSB-36,	Technical Systems Bulletin, Additional Cable Specifications for Unshielded Twisted Pair Cables
TSB-40,	Technical Systems Bulletin, Additional Transmission Specifications for UTP Connecting Hardware
TSB-53,	Extended Specifications for 150-Ohm STP and Data Connectors
U. S. Department Agriculture, Rural Electrification Administration (REA) Publications	
Bulletin 344-2 Jan. 1981	List of Material Acceptable for Use of Telephone Systems for REA Borrowers
Bulletin 345-6 PC-2 Jan. 1978	REA Standard for Splicing Plastic Insulated Cables(PC-2)
Bulletin 345-13 PE-22 Jan. 1978	REA Specification for Aerial and Underground Telephone Cables (PE-22)
Bulletin 345-29 PE-38 Feb. 1982	REA Specification for Self Supporting Telephone (PE-38)
Bulletin 345-63 PC-4, May 1976	REA Standard for Acceptance tests & Measurements of Telephone plant
Bulletin 345-67 PE-39, Mar 1979	REA Specification for Filled Telephone Cables

Bulletin 345-89  
PE-89, Oct. 1982

REA Specification for Filled  
Telephone Cable with  
Expanded Insulation. PE-89

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and ANSI C2.

### 1.2.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

### 1.2.3 Standard Products

Materials and equipment shall be new and the standard products of manufacturers regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use for at least 2 years prior to bid opening. The system(s) shall be of the latest electronic designs in current production.

### 1.2.4 Cable

All underground cable shall be filled type PE-89 telephone cable and shall conform to the requirements of REA Bulletin 345-89. All aerial cable shall be air-core type telephone cable and shall conform to the requirements of REA Bulletin 345-29.

### 1.2.5 Workmanship

All materials and equipment shall be installed in accordance with recommendations of the manufacturer to conform to the contract documents. Journey telecommunication workman (with a minimum of three years at the journeyman level) skilled in this type of work shall accomplish the installation.

### 1.2.6 Installation Requirements

Underground cables shall be installed on or in supporting structures. All work shall be scheduled in accordance with requirements of SECTION; SUPPLEMENTARY REQUIREMENTS. The Contractor shall coordinate with the local Directorate of Information Management (DOIM) Plans Division Cliff Hawkeswood (253) 967-6789 or others as designated by the Fort Lewis DOIM.

### 1.2.7 Assembly Details

The Contractor shall perform his work in accordance with the assembly details shown on the drawings and attached at the end of this section when available.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals having a "FIO" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

Shop Drawings: G;

The Contractor shall submit, for approval, shop drawings for the items listed below and for any other items as directed by the Contracting Officer. Submittal shall be made in accordance with paragraph SUBMITTAL of the SPECIAL CLAUSES. Shop drawings shall be submitted for the following items:

Cable

Closures and Splice Cases

Backboards

Protected/Unprotected Terminals

Gas Module Protectors

Manholes

Handholes

Duct

Jacks & outlets internal to the building

List of Equipment and Materials: FIO;

A complete itemized listing of equipment and material proposed for incorporation into the work shall be submitted before installation of any item. Each such itemization shall include an item number, the quantity of items proposed, name of the manufacturer of each such item, and the manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. The Contractor shall update the list at completion of the Contract to show the actual material used, prior to final payment.

Performance Test Reports: FIO;

In addition to the requirements of SECTION: SUPPLEMENTARY REQUIREMENTS. Upon completion and testing of the installed system, comprehensive test reports shall be submitted in a booklet form and in electronic CAD format and shall show that all field tests confirm compliance with the specified performance criteria and paragraph 10.1.2

Qualifications of Cable Splicer(s): FIO;



Before assigning any cable splicer(s) to do work, the Contractor shall: provide the Contracting Officer with the name(s) to be employed. Together with satisfactory proof that each splicer has had at least three years experience in splicing telephone cables and is experienced with the type and rating of the cables to be spliced. In addition, each splicer may be required to make an approved dummy splice in the presence of the Contracting Officer, in accordance with the manufacturer's instructions, before the splicer is approved to splice cable. The Contractor shall furnish all material for dummy splices.

Acceptance Test Plan: G;

The Contractor shall submit to the Contracting Officer for approval a complete detailed acceptance test plan.

Cutover Plan: G;

The Contractor shall develop a cutover plan. The cutover plan shall be submitted for the Contracting Officers approval 30 days prior to scheduled start of acceptance tests. The cutover plan shall provide procedures and schedules for splicing indicated telephone cables to the overall facility's telephone system without interrupting service to any active cable pairs.

Installation and Maintenance Tools: FIO;

30 days prior to scheduled start of acceptance tests, the Contractor shall provide to the Contracting Officer the equipment manufacturer's recommended list of installation and maintenance tools required for normal servicing of the installed equipment. These tools and equipment shall become the property of the Army and be picked up on the hand receipt of the appropriate 1115<sup>th</sup> Signal Battalion division.

As Built Drawings: G;

The Contractor shall annotate three sets of telephone system drawings to show the as-built condition and provide them to the Contracting Officer for delivery of one copy to the Director of Public Works and two copies for the 1115th Signal Battalion Plans Division. This shall include, but not be limited to, all cable types, sizes, counts, measured distances to all splices and terminals, terminal numbers and any other details and sketches necessary for preparation of accurate plant-in-place type record drawings. As-built drawings shall be annotated utilizing red and yellow (red for additions and yellow for deletions). Red line drawings to be submitted in electronic format (Auto-CAD or Intergraph) and are required in addition to "D" size paper copies.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND COMPONENTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.

## 2.2 TELEPHONE CABLE

Solid copper conductors, Aerial: REA Bulletin 345-29.

## 2.3 UNDERGROUND

Filled telephone cable with expanded insulation, type PE-89.

## 2.4 FIBER OPTIC CABLE

Fiber Optic Cable shall be at minimum twenty-four (24) strands or more as specified, single-mode fiber optic cable. Fiber Optic Cable shall be connected from nearest RSU to communication room in the building. Fiber shall be one continuous cable without splices.

## 2.5 INTERIOR FIBER OPTIC CABLE

Interior fiber optic cable shall be two strands or greater, single-mode. Fiber optic cable shall be installed to each identified multi media outlet, home run to an ST fiber optic patch panel in a central hub location, as outlined on the drawings. Internal fiber optic cable shall not be jell filled.

## 2.6 HARDWARE

All ferrous hardware, screws, and associated miscellaneous items shall be galvanized or cadmium plated to prevent rust and corrosion.

## 2.7 TERMINATION OF WIRES/FIBERS

66 type connecting blocks shall be provided and utilized to terminate voice circuits on the backboard. Category 5, 110 type Patch panels shall be used to terminate and facilitate patching of the data portion of the LAN wiring. Fiber optic patch panels utilizing ST type connectors shall be used to terminate all fiber optic cable. All fiber optic patch panels and Category 5, 110 type RJ-45 patch panels shall be installed in contractor provided 19" enclosed equipment cabinet.

## 2.8 MISCELLANEOUS MATERIALS

All miscellaneous material provided shall be current standard models, series, or type regularly advertised as such on the approved list of materials acceptable for use on REA Borrower's System, REA Bulletin 344-2.

## 2.9 MANHOLES

New manholes shall be equipped with pulling-in irons, cable racks, and ground rod, and conform to the requirements of REA Bulletin 345-151. Manholes shall be a minimum of 3.7 m long by 1.8 m wide by 2.0 m high. Manholes shall be designed so that the main trunk conduits enter and exit near the center of the ends, and lateral conduits exit on the sides near the corners. Manholes may be pre-cast or cast in place. Precast Concrete, Utility Vault Co model number 612-7-TCA or approve equal.

## 2.10 DUCT

### 2.10.1 Plastic Duct

Conduit shall be furnished as specified in Sections 16415 ELECTRICAL WORK, INTERIOR and 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown on project drawings.

### 2.10.2 Innerduct

Innerduct shall be SDR 11.5 polyethylene plastic pipe conforming to ASTM D 2239. Four, separate color, one and one quarter inch plastic hollow core innerduct, installed into one four inch conduit or multiple core (Minimum of 4 cells in a 4" diameter pipe), type Phone-Ducts, Inc. or approve equal.

## 2.11 EQUIPMENT RACKS

Distribution frames, cabinets, and back-boards shall be provided as shown and designed to mount connector blocks, protector blocks, cross connects, and other hardware required to terminate and protect the outside telephone plant cable; to provide a demarcation point between inside and outside plant cable; and to allow inside and outside plant cable to be cross connected.

### 2.11.1 Floor Mounted Open Frame

Floor mounted equipment racks shall be welded steel relay racks with uprights to mount equipment 480 wide. Uprights shall be 75 mm deep channel, 32 mm inch wide, drilled and tapped 12-24 in a 13 mm pattern. Racks shall be provided with a standard top cross-member, and predrilled base plate to allow floor fastening. Open frame equipment racks shall be 2.1 m in height and painted. AC outlets shall be provided as shown.

### 2.11.2 Wall Mounted Open Frame

Wall mounted open frame equipment racks shall be steel relay racks to mount equipment 480mm wide with standoff brackets for wall mounting. Uprights shall be drilled and tapped 12-24 in a 13 mm pattern. Standoff brackets shall be of sufficient length for a 150 mm clearance between rack and wall. Wall mounted open frame racks shall be hinged. AC outlets shall be provided as shown.

### 2.11.3 Cable Guides

Cable guides shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 480mm equipment racks. Cable guides shall consist of ring or bracket-like devices mounted on rack panels for horizontal use or individually mounted for vertical use. Cable guides shall mount to racks by screws and/or nuts and lock-washers.

### 2.11.4 Floor Mounted Cabinets

Equipment cabinets shall be floor mounted enclosures with side panels, acrylic plastic front doors, rear louvered metal doors, depth-adjustable front and rear mounting rails, and louvered top. Ventilation fans shall be included. Vertical cable management devices shall be integral to the cabinet. Power strips with 12 outlets shall be mounted within the cabinet. Equipment racks

shall mount equipment 480 mm wide and shall be 1828 mm high and 760 mm deep. Cabinet exteriors shall be painted ivory/off-white.

#### 2.11.5 Wall Mounted Cabinets

Wall mounted cabinets shall conform to UL 50 and have boxes constructed of zinc-coated sheet steel with dimensions not less than shown on drawings. Trim shall be fitted with hinged door and flush catch. Doors shall provide maximum openings to the box interiors. Boxes shall be provided with 19 mm plywood backboard painted white or a light color. A duplex AC outlet shall be installed within the cabinet.

#### 2.11.6 Equipment Mounting Backboard

Backboards shall be 19 mm AC plywood, sized as shown, painted with white or light colored paint.

### 2.12 CONNECTOR BLOCKS

Connector blocks consisting of flame-retardant molded plastic fastened to a metal mounting bar shall be provided to terminate the outside plant cable as shown. The connector blocks shall be of 100-pair block size and equipped with protection modules. The connector blocks shall be 24 gauge stub type. The cable stubs shall be 100 pair and conform to REA Bulletin 1753F-207 (PE-87).

### 2.13 PROTECTOR MODULES

The protector modules shall be of the two-element gas tube type. Protection modules shall be heavy duty,  $A > 10$  kA,  $B > 400$ ,  $C > 65A$  where A is the maximum single impulse discharge current, B is the impulse life and C is the AC discharge current per ANSI C62.61. The gas modules shall shunt high voltage to ground, fail short, be equipped with an external spark gap and heat coils, and shall comply with UL 497.

### 2.14 FIBER-OPTIC TERMINATIONS

#### 2.14.1 Fiber Optic Connectors

All outside plant fiber strands shall be terminated in a ST type fiber optic connector, with ceramic ferrule material and a maximum insertion loss of 0.5 dB. Connectors shall meet performance standards of EIA ANSI/TIA/EIA-568-A. If pre-connectorized cable assemblies or pigtails are used, the connectors shall be terminated on a 3 m length of single-fiber cable. The single-fiber cable shall contain a buffered optical fiber of the same type and specification as that used in the multi-fiber cable.

#### 2.14.2 Fiber Optic Patch Panels

Patch panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-

connection. Patch panels shall be 480mm rack mounted panels. Patch panels shall provide strain relief for cables. Panels shall be provided with labeling space. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the system.

## 2.15 MISCELLANEOUS ITEMS

### 2.15.1 Shield Connectors

Shield connectors shall make a stable, low-impedance electrical connection between the shield of the communications cable and a conductor such as a strap, bar, or wire. The connector shall be made of tin-plated tempered brass. Shield bond connectors shall comply with REA Bulletin 345-65.

### 2.15.2 Grounding Braid

Grounding braid shall provide low electrical impedance connections for dependable shield bonding. The braid shall be made from flat tin-plated copper.

### 2.15.3 Warning Tape

Marking and locating tape shall be acid and alkali resistant polyethylene film, 150 mm wide with a minimum strength of 12.1 MPa lengthwise and 10.3 MPa crosswise. The tape shall be manufactured with integral wires, foil backing, or other means to enable detection by a metal detector when the tape is buried up to 1 m deep. The metallic core shall be encased in a protective jacket or provided with other means to protect it from corrosion and shall be specifically manufactured for marking and locating underground utilities. The warning tape shall be orange in color and continuously imprinted with the words "WARNING - COMMUNICATIONS CABLE BELOW" at not more than 1.2 m intervals.

### 2.15.4 Cable Warning Signs

Cable warning signs, which identify the route of buried cable, shall be stake mounted. The stake shall be driven into undisturbed soil and the sign shall be mounted to the stake in accordance with the manufacturer's instructions. Warning signs shall be placed at intervals of no more than 152.5 m and at each change of direction in the cable route. Warning signs shall also be placed on each side of every crossing of surface obstacles such as roads, railroads, stream crossings, or any similar crossing where excavation is likely to occur.

## PART 3 - EXECUTION

### 3.1 MANHOLE/HANDHOLE SYSTEM

#### 3.1.1 General

The Contractor shall provide and install new precast telephone manholes and Hand holes as shown on the assembly drawings. Manhole/ Handhole types shown on the assembly drawings have been determined to be the most desirable; however due to subsurface conditions, normal drainage, or other underground conditions, manhole/handhole shall be approved by the Contracting Officer prior to installation. All new manholes/handholes shall be

temporarily numbered for clarity. The Contractor shall acquire the permanent manhole/handhole number from the Contracting Officer and all drawings shall be annotated showing the assigned number.

### 3.1.2 Manhole/handhole Construction

Manholes shall be equipped for double racking. Each manhole shall have pulling irons installed in the wall opposite each duct line entrance. Each manhole shall have a sump with a cast iron grill-type frame and cover. Each manhole/handhole shall be provided with a ground point. The ground rod hole shall be used and a ground rod shall be installed and cables grounded as specified. Each manhole/handhole shall be provided with an entrance collar, frame, and cover.

### 3.1.3 Covers for Manhole/handhole

Covers will utilize reducing entrance collars, as required, to provide for a contractor furnished and installed thirty (30) inch diameter manhole cover, and be marked "COMMUNICATIONS" All existing manhole covers shall be replaced to comply to the above standard if currently using a larger lid size.

### 3.1.4 Manhole/handhole Placement

In paved areas, the top of the manhole/handhole covers shall be 1/4" above the finished surface of paving and shall be approved for vehicular loads. In unpaved areas, the top of the manhole/handhole covers shall be approximately 1/2 inch above the finished grade. One 6" and two 12" risers shall be installed between the top of the manhole/handhole and the manhole/handhole frame to elevate the manhole/handhole cover to the desired height of the finished grade. Manholes/handholes shall be placed with a minimum of 36-inch cover above the structure.

## 3.2 CONDUIT SYSTEM

### 3.2.1 General

The Contractor shall provide a new underground concrete encased conduit system as shown on the drawings. The Contractor provided conduit shall be 103mm (4") schedule ~~8040~~ plastic or type EB conduit/duct with at least one of the 103mm (4") ducts being multi duct. Lengths of each duct run shall be determined from the assembly drawings and field verified before installation. Additional information on conduit placement and arrangement may be provided.

### 3.2.2 Conduit Placement

All conduit lines shall be laid to a minimum grade of 100mm per 30.5 meters (4-inch per 100-feet). The grade may be from one manhole or handhole to the next or both ways from the high point between manholes or handholes depending on the contour of the finished grade. Grade changes, bends and entrances into manholes/handholes shall be made using components and/or accessories recommended by the manufacturer of the conduit installed. All conduits shall be thoroughly cleaned before using or laying. Particular care shall be taken to keep the conduit clean of dirt, concrete, and any other substance during installation. After the conduit has been installed, flexible mandrel not less than 305 mm (12-inches) long, with a diameter

approximately 8mm (1/4-inch) less than the inside diameter of the duct shall be pulled through each duct. This is to make certain that no particles of earth, sand or gravel has been left in the duct. Pneumatic rodding may be used to draw in the lead wire/cord. Conduit shall be stored to avoid warping, deterioration or direct rays of the sun. Conduit shall be placed with a minimum 914mm (36-inch) cover and may be indicated on assembly drawings. Conduit must be installed in the bottom most holes in the manholes or handholes. Conduit must be installed deep enough as to allow all manhole entrance ports (if used now or in the future) to have conduit installed and maintain a minimum of 914mm (36 inch) of cover over the uppermost conduit. Concrete encasement is required for all duct/conduit runs. Existing conduit runs to be utilized on all projects shall also be thoroughly cleaned of dirt and foreign debris before pulling in and after removing cable. Any conduit system that will be reduced to less than two vacant ducts must be over-built to allow for a minimum of two vacant restoration ducts/conduits.

### 3.2.3 Conduit Cement Encasement

Concrete slurry 1200-1800 LB pourable concrete (Also known as {CDF} Controlled Density Fill) shall completely encase conduit to protect it from being dug up. Metal ribbon shall be placed above the cap to provide for ease of conduit location. The ribbon must maintain electrical connectivity from the beginning to the end of each conduit job and be patched across the top of each manhole.

### 3.2.4 Conduit Under Road, Streets and Driveways

The Contractor shall encase duct in full strength concrete under all drives, street, road and at all bends of 15.2 meters (50-feet) or less radius.

## 3.3 CABLE SYSTEM

### 3.3.1 General

Cables shall be installed, terminated and spliced as indicated. The Contractor shall complete all splices, furnish all splicing material and associated hardware, tag all cables and stencil cables. Inside terminals and splices in manholes/handholes shall be grounded as specified in grounding requirements. Prior to commencement of construction the Contractor shall coordinate with the Fort Lewis DOIM through the Contracting Officer on all communications interfacing requirements as stated by this specification.

### 3.3.2 Testing Existing Cables

Prior to start of this project, the Contractor shall test all pairs in the cable to be spliced into under this project. The Contractor, in accordance with the Contracting Officer, shall prepare a list of the defective cable pairs under form "Cable Status Certificate" attached at the end of this section. This list will be known as the original list. After project is completed, all pairs shall be tested. The Contractor shall clear trouble on any pairs that were not defective on the original list.

## 3.4 CABLE

All telephone cable furnished and installed under this specification shall have the number of insulated twisted pairs of copper conductors as required. Cables shall be specified to include

number of pairs and conductor gage and be of filled core with polyethylene sheath and polyethylene insulated conductors.

### 3.4.1 Color Coding

The cable shall be fully color-coded. The basic industry standard color scheme shall be used to provide different colors of insulation for each pair of a 25 pair group.

### 3.4.2 Guaranteed Pairs

All pairs in each cable shall be certified as usable.

### 3.4.3 Splices

#### 3.4.3.1 General

Splicing of cable into one continuous length is required. All pairs shall be spliced, including those indicated as dead pairs. Unless otherwise noted. Splicing shall be in accordance with industry standards. The completed splices shall not cause the connected cable to fail to meet the same performance and mechanical specifications of a single similar cable of the same overall length. Plastic insulated conductors shall be spliced using self piercing electrical filled connectors, such as PICA-A-Bond conductors, or other filled connectors suitable for splicing plastic insulated cable. Connectors shall be placed using a tool specifically designed to place those connectors. Modular splicing techniques shall be utilized on all mainline splices using 3M Company, 25 pair, modular (MS2) splice connectors, type 400 DWP with sealant boxes. Other variations such as Super Mini half-tap modules shall be utilized as required. Filled connectors and sealant boxes shall be used wherever applicable. All outside cable splices shall be watertight. Cable sheaths shall be bonded together at all cable splices with bonding harness to maintain sheath continuity. Splices shall be grounded to the manhole/handhole ground system. Deviation from the cable splicing arrangements shown on the project drawings will not be allowed except as specifically approved by the Contracting Officer.

#### 3.4.3.2 Closures

As needed, type to be determined by Fort Lewis (OSP) Out Side Plant, personnel.

#### 3.4.3.3 Underground

All underground splice cases shall be preformed splice cases or equal and shall be flash tested. Encapsulating compounds shall not be used.

### 3.4.4 Cable Installation

Cables shall be handled and placed in such a manner as to avoid kinks and other sheath deformities. Minimum bending radius of all cables shall be twenty times the diameter of the cable. Cable kinked or flattened shall not be installed. Lead sleeves and/or duct splices shall not be permitted. Cable lubricant shall be used in the installation of underground cable. The quantity of lubricant used shall be as recommended by the manufacturer. Cable racks and hooks shall be installed in all manholes and used to support cables installed. All outdoor connections shall be weather proof through the use of weather boots or other approved methods. All aerial cable



entrances into buildings shall have a drip loop formed in the cable at point of ingress. All building entrance points shall be sealed and waterproof.

#### 3.4.5 Duct Sealant

After cable has been placed, each lateral duct at the building, entrance and exit duct in each manhole/handhole, and riser shall be sealed with 3M Scotchcast 4416T or approve equal sealant compound. Unused ducts shall be sealed in each building they enter.

#### 3.4.6 Cable Tags

Embossed cable tags shall be placed on all underground cables on each side of all splices. Including stub cables and branch cables. Each tag shall be stamped or permanently marked to indicate the cable size, gauge, cable number and number of first and last pair of each group of consecutive pairs which is in the main cable, stub cable or branch cable to which tag is attached. The number of dead pairs, if any shall also be designated.

#### 3.4.7 Cable Bonding

Cable in manholes shall be bonded in accordance with paragraph, 3.9 GROUNDING.

#### 3.4.8 Cable Guard Protectors

All underground to overhead cable shall have cable guard protectors installed. The guard protectors shall be Cahne No. 6533 or approve equal.

### 3.5 CABLE TERMINAL INSTALLATION

All cable terminals furnished and installed under this specification shall be complete.

#### 3.5.1 Terminal Number

A terminal number shall be obtained from the Contracting Officer for each terminal shown on the project drawings. The Contractor shall stencil the terminal number on each terminal and shall redline the appropriate drawings.

#### 3.5.2 Cable Protector terminals

Cable protector terminal shall be RELTEC R399 wire wrap front facing terminals (or equal) and shall be stenciled to indicate cable number and cable pairs, using black marking on a white designation strip. Stubs shall be used from the R399 to the appropriate splice case. Frames and wall mounting brackets shall be provided as required to effectively secure the protected terminals. Grounding of each protected terminal with #6 AWG is required to the nearest ground point.

#### 3.5.3 Patch Panels

Patch panels 110 type RJ-45 category 5 patch panels shall be provided and installed by the contractor. The DATA LAN will be terminated on this panel and will be marked at both the multi media box and the 110 type RJ-45 category 5 patch panels for easy identification.

### 3.5.4 Bonding

All protected terminals installed shall be bonded as specified in paragraph, GROUNDING.

## 3.6 CABLE INSTALLATION STANDARDS

### 3.6.1 Underground Cable

3.6.1.1 Where existing ducts and conduit are identified for the installation of underground cable, the installation shall be coordinated with the local DOIM. Underground cable shall not be placed in the conduit, Manhole or duct with power wiring.

3.6.2.2 All underground cable shall be carefully pulled into conduit, using sheaves of the proper diameter and shoes or guides at all sharp edges. The cable shall be fed directly from the reel if possible, and shall be continuously inspected as it is unreeled for physical damage. Cable pulling lubricant as recommended by the cable manufacturer shall be used to prevent exceeding the tensile strength rating of the cable.

## 3.7 WORK DESCRIPTION

The Contractor shall provide all material and labor for the installation and placement of a complete operational underground cable system.

### 3.7.1 Fiber Optic

#### 3.7.1.1 Multi-Mode:

Multi-Mode fiber optic cable shall not be installed without prior consent of the Fort Lewis DOIM.


#### 3.7.1.2 Single-Mode

Contractor is to provide and install (see contract drawings) single mode fiber optic as Specified.

### 3.7.2 Patch Panel

The Contractor shall furnish and install the required number of 110 type RJ-45 patch panels, in the hub locations, to connect (2) TWO four pair category 5 Data LAN cables to each multi-media outlet. Cables are to be terminated in the category 5 RJ-45 multi-media outlet box connectors at each multi-media outlet location and on the 110 type Category 5 RJ-45 patch panels in the hub location. (Note: See attached Building communication room and multimedia drawings)

### 3.7.3 Outlets

ALL outlets are considered "Multimedia Outlet" except outlets specifically marked " wall phone". All Multimedia drawings will use this filled triangle (  ) to indicate each multi-media box location.

a. The Contractor shall furnish and install 1 additional four pair Category 5 copper wire from the backboard to each multimedia outlet, home run style, for connection of the voice circuits. See Multimedia outlet drawing in this specifications.

b. The Contractor shall furnish and install all other items necessary to provide a complete and usable system.

### 3.8 INSIDE PLANT

#### 3.8.1 General

The Contractor shall furnish and install all cabling and equipment as indicated to provide a complete telephone system. All requirements shall be satisfied by commercially available equipment, which is compatible with and will interface with the existing equipment.

#### 3.8.2 Instruments

None required unless specifically addressed in bid documents.

### 3.9 GROUNDING

#### 3.9.1 General

Except where specifically indicated otherwise, all exposed non-current carrying metallic parts of telephone equipment, cable sheaths, cable splices and terminals shall be grounded. All grounding shall be accomplished in such a manner that a maximum of 105 ohms to ground resistance is obtained. When it is necessary to place more than one ground rod to meet this requirement, the minimum separation between rods shall be 1830mm. Two or more ground rods shall be connected using No. 6 AWG solid copper wire. The connection of the No. 6 AWG solid copper wire to the ground rods shall be made either with compression sleeves or fusion weld connections.

##### 3.9.1.1 Bullet Bonds

Use of bullet bonds required on all copper cables for the grounding and bonding of all sheathed cables.

##### 3.9.1.2 Terminals

Inside type protected terminals shall be grounded using a NO. 6 AWG insulated solid copper wire. The ground wire shall be continuous from the ground lug, or the grounding strip of the terminal, to driven ground rod or rods as required. When a ground rod (minimum diameter of 5/8 inch and a minimum length of 8 feet) is placed, it shall be a minimum distance of 12 inches from wall of building. It shall be driven to a depth that shall provide a minimum of 6 inches depth of cover between the top of the ground rod and ground level. The ground wire shall be continuous from the terminal or the driven ground rod and shall be placed in conduit where exposed or

attached to supporting surface using either staples or one-hole clamps placed at 18 inch intervals and protected.

#### 3.9.1.3 Manholes

A Standard bonding ribbon shall be used to ground all installed splices to the manhole grounding system. Bonding ribbon shall be attached to the manhole walls on 18-inch centers with bonding ribbon clamps where no ribbon exists or in new manholes.

#### 3.9.1.4 Ribbon

Ribbon shall be placed vertically behind existing led sleeves, metallic splice cases of rigid plastic splice closures, Behind new metallic splice cases or rigid plastic closures. Or, where it is necessary to run to another wall, shall be placed vertically to the ceiling and then routed to the required location.

#### 3.9.1.5 Folded Projection

A 1/2 inch folded projection shall be placed every 5 1/2 inches in the bonding. All metallic cable sheaths are to be bonded to manhole ribbon.

#### 3.9.1.6 Bonding Ribbon Clamps

Bonding ribbon clamps shall be attached to walls using 1/4-inch X 1-inch hammer drive anchors.

#### 3.9.1.7 Repair of existing work

All work shall be carefully laid out in advance. The Contractor shall be responsible for the repair of any damage resulting from the cutting, channeling and chasing necessary for the proper installation, support, or anchorage of the conduit or raceway, at no additional cost to the Government.

### 3.10. QUALITY CONTROL

#### 3.10.1 General

All work shall be in accordance with SECTION: SUPPLEMENTARY REQUIREMENTS and the following Provisions.

#### 3.10.2 Installation Inspections

##### 3.10.2.1 Pre-operational Inspection

An Inspection shall be made by the Contractor and Contracting Officer of all equipment to be utilized in this project. All equipment shall be verified for proper conformance to the demands and expectations of the installation, as dictated by the specification. All cables shall be inspected for abrasions, breaks and deformities, utilizing those methods stated in the Government-approved acceptance test plan to determine the integrity of the cable. This inspection shall also insure the adequacy of site readiness, availability of installation materials, status of Contractor-Furnished Equipment, as well as leased equipment and transmission facilities, if needed.

### 3.10.2.2 In-Progress Inspections

In-progress inspections of the Contractors effort will be as required by the Contracting Officer and may encompass visual inspections of equipment condition, wiring, splicing, cabling, mounting and placement of equipment, miscellaneous hardware, system operational status, and adherence to safety procedures.

### 3.10.2.3 Final Inspection

The final inspection conducted by the Contracting Officer will encompass all phases of installed equipment. This inspection includes, but is not necessarily limited to, aerial, or underground cable runs and supports, splices, manholes, handholes, terminals, apparatus or miscellaneous equipment.

### 3.10.3 Corrective Measure

The Contractor shall correct any areas of noncompliance that are revealed by inspection evaluation. Following correction completion, a re-examination of any of all areas of non-conformance may be conducted at the discretion of the Contracting Officer.

## 3.11. ACCEPTANCE TESTS

### 3.11.1 General

All testing shall be performed in accordance with the Contractor-developed, approved acceptance test plan and as specified herein. Construction of test and inspections utilizing the approved acceptance plan shall demonstrate compliance with all requirements of the specification.

#### 3.11.1.1 Test Witnessing

All tests shall be performed in the presence of the Contracting Officer excluding in-progress cable testing. The Contractor shall record all test data, as witnessed by the Contracting Officer and provide a record copy to the Contracting Officer. The Contractor shall notify the Contracting Officer a minimum of seven (7) working days prior to conducting any equipment or acceptance tests.

### 3.11.2 Cable Tests

Project integrity shall be ensured through pre-installation cable tests, in-progress tests, and final acceptance test of the cable installed. Requirements for cable integrity, splicing insulation, and loop resistance, as well as provisions for handling materials in such a way as to prevent damage, shall be demonstrated. The Cable Status Certificate shall be used as a documenting log when performing this test.

#### 3.11.2.1 Pre-Operational

As a minimum, all new cable lengths shall be serviceability tested by the Contractor prior to installation to avoid placing unserviceable cable. The certificate shall be annotated to indicate

that the test was conducted on non-connected (dead) cable. Tests so conducted shall be of a nature to verify:

Insulation Resistance

Shorts

Crosses

Opens

Grounds

Splits

#### 3.11.2.2 In-progress

Cable shall be tested by the Contractor to reveal any faults in cable construction. Such standard tests for correct pair identification and termination shall be performed prior to and during the splicing operation. Correct pair termination constitutes proper continuity verification of the wires being spliced.

#### 3.11.2.3 Final

A final test of the work performed shall be made by the Contractor in the presence of the Contracting Officer to demonstrate the acceptability of the project as installed. Testing shall be performed in accordance with REA Bulletin 345-63, PC-4. Final testing shall consist of, but will not necessarily be limited to the following cable tests:

Insulation Resistance

Shorts/Crosses

Grounds

Opens

Shield Continuity

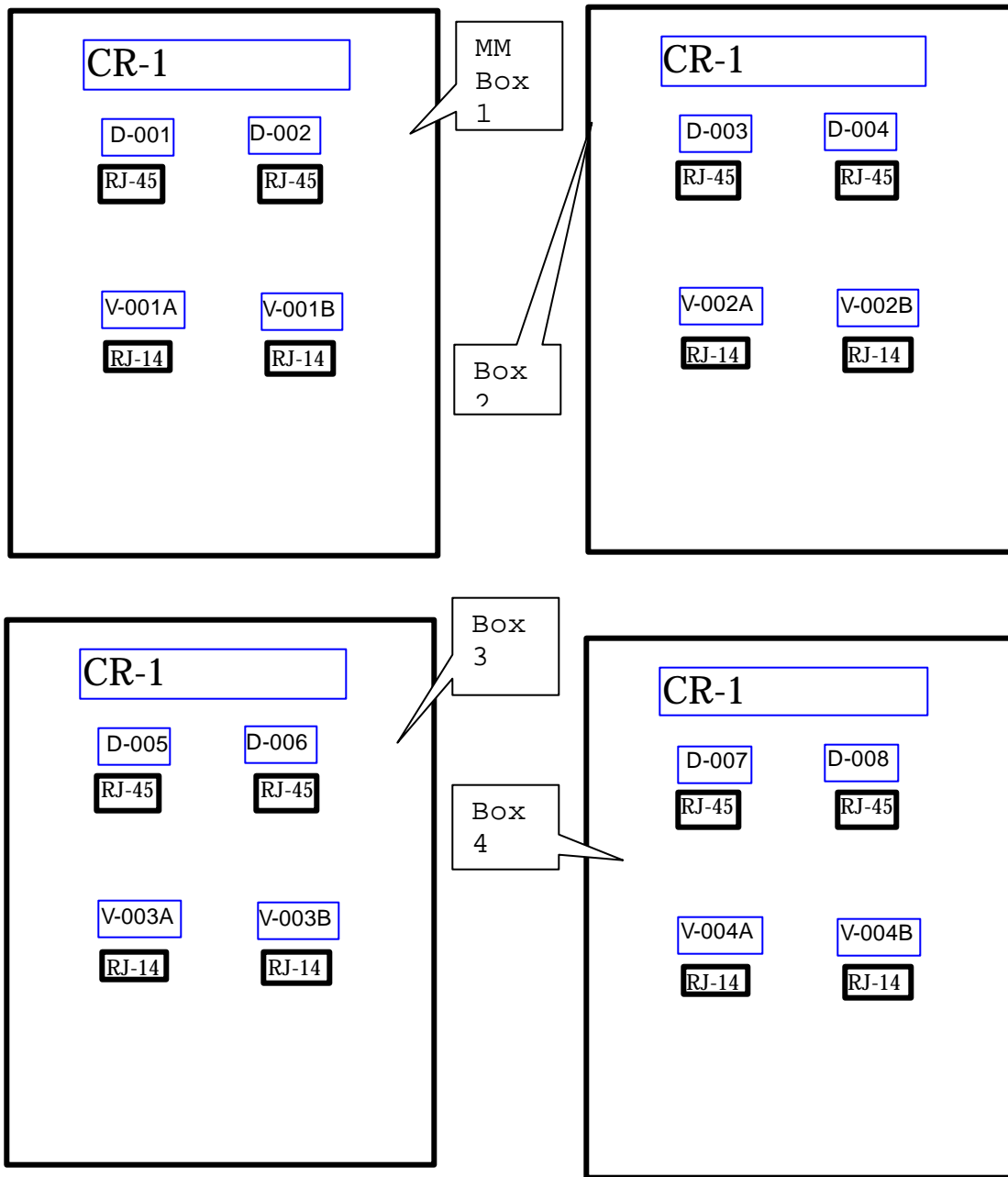
Loop Resistance

Reversed Pairs

Split Pairs

## Standard Fort Lewis Multi-Media Communication outlet Labeling

CR= Communication room #. Label each multimedia box with CR# if more than one communication room is used on each floor.  
All Data port numbering shall be sequential from jack to jack.  
Both Voice jacks in each Multi Media box will use same number with A or B designation in each multimedia box when a single 4 pair cable is used.  
Use pair 1 for A (White Blue pair) use pair 2 for B (white Orange pair) pair 3 & 4 to remain un-terminated.  
Room numbers change and are not to be a part of the numbering system.  
D = Data  
V = Voice

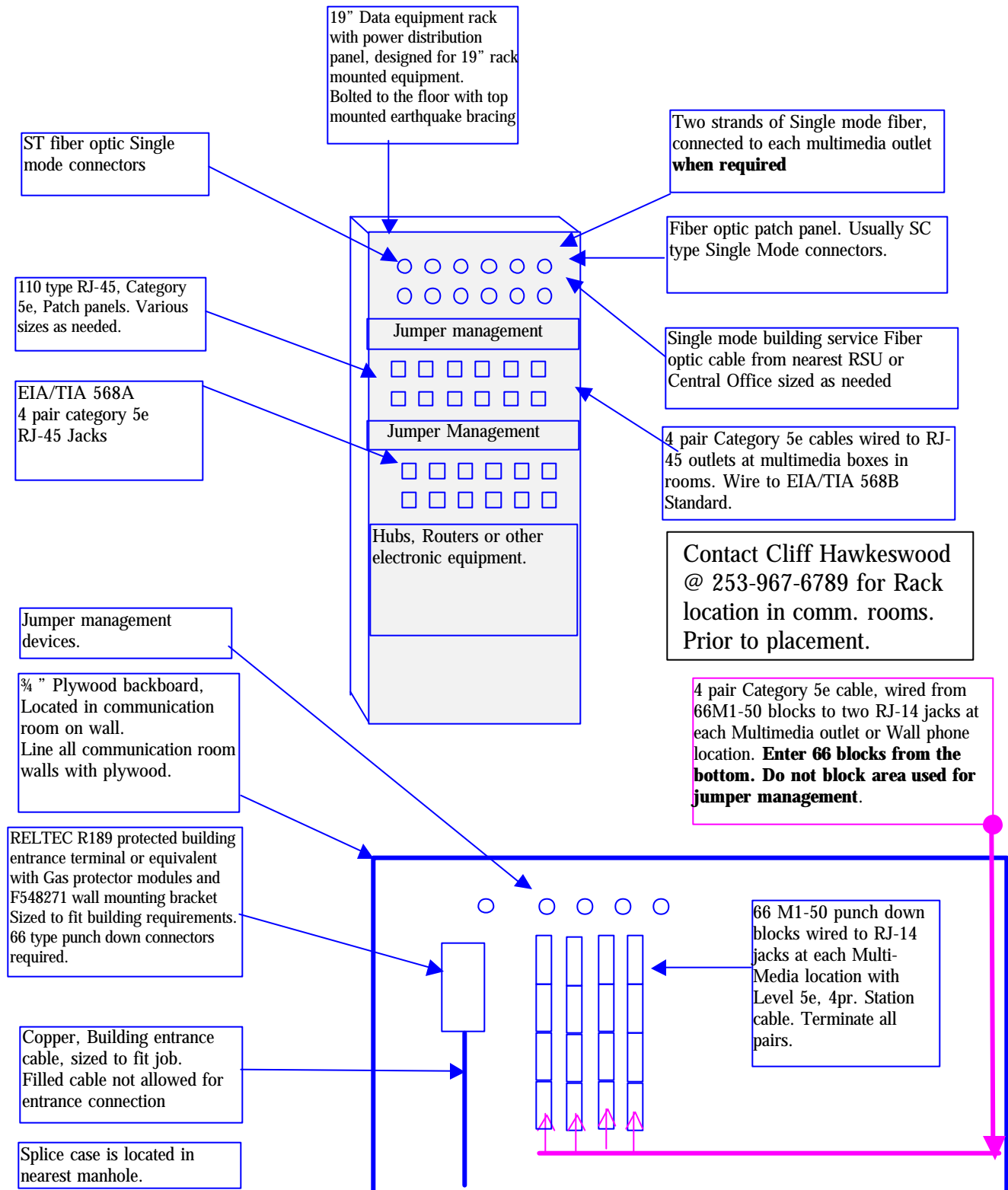


Floor Designation is not required unless outlet is wired to a communication room located on a different floor.  
Communication room designation required if more than one-communication rooms exist on each floor.





### Typical Fort Lewis communication room layout



Typical Fort Lewis communication room layout  
Small Wall Mount installations if approved

